Forest Research

Forest Development Types: FDT Flashcards

Version 1.1

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Forest Research is the Research Agency of the Forestry Commission and is the leading UK organisation engaged in forestry and tree related research. The Agency aims to support and enhance forestry and its role in sustainable development by providing innovative, high quality scientific research, technical support and consultancy services.

Index of FDT Flashcards – to be used in association with FDT management guide

Individual Flashcards are presented in numerical order after the index.

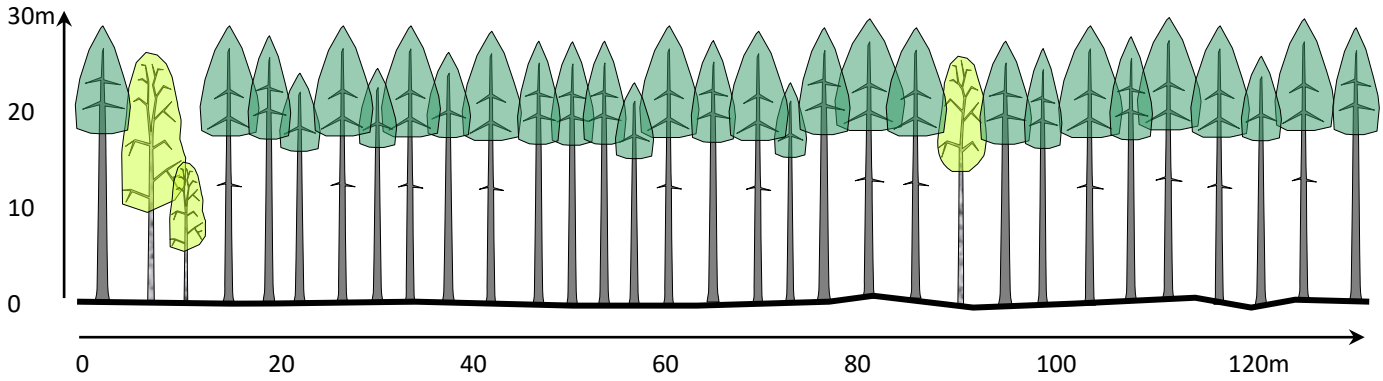
FDT ID code			primary species	primary species proportion [%]	secondary species.	secondary species proportion [%]	Stand structure				Short title
							even-aged unthinned	even-aged thinned	uneven-aged simple	uneven-aged complex	
1	1	1	SS	90-100			x	x*			Sitka spruce
1	1	2	SS	80-90					x*	x	Sitka spruce LIMA/CCF
1	1	3	SS	60-80	DF	20-40		x	x*	x	Sitka spruce and Douglas-fir
1	1	4	SS	60-80	XCLD	20-40	x	x*	x	x	Sitka spruce and pine/larch
1	1	5	SS	60-80	XCST	20-40		x	x*	x	Sitka spruce and shade tolerant conifers
1	1	6	SS	70-90	BE	10-30		x*	x	x	Sitka spruce and beech
1	1	7	SS	50-90	XBLL	10-50		x	x*	x	Sitka spruce and long-lived broadleaves
1	1	8	SS	50-90	XBSL	10-50	x	x*			Sitka spruce and short-lived broadleaves
1	2	1	NS	90-100			x	x*			Norway spruce
1	2	2	NS	80-90					x*	x	Norway spruce LIMA/CCF
1	2	3	NS	70-90	SS	10-20	x	x*	x	x	Norway spruce and Sitka spruce
1	2	4	NS	60-80	XCST	20-40	x	x	x*	x	Norway spruce and shade tolerant conifers
1	2	5	NS	50-70	BE	20-40		x	x	x*	Norway spruce and beech
1	2	6	NS	60-80	XBLL	20-40		x	x*	x	Norway spruce and long-lived broadleaves
1	2	7	NS	70-90	XBSL	10-30	x	x*			Norway spruce and short-lived broadleaves
2	1	1	SP	80-100			x	x*			Scots pine
2	1	2	SP	70-90				x	x*	x	Scots pine LIMA/CCF
2	1	3	SP	60-80	XCST	20-40			x*	x	Scots pine and shade tolerant conifers
2	1	4	SP	60-90	XCLD	10-40		x*	x		Scots pine and light demanding conifers
2	1	5	SP	50-70	SOK	20-40				x*	Scots pine and oak
2	1	6	SP	60-80	BE	20-40		x	x*	x	Scots pine and beech
2	1	7	SP	60-90	SBI	10-40		x	x	x*	Scots pine and birch
2	2	1	CP	30-70	XCST	30-70			x*		Corsican pine transition to shade tolerant conifers
2	2	2	CP	30-70	XCLD	30-70		x*	x	x	Corsican pine transition to pine/larch
2	2	3	CP	30-70	XBLL	30-70			x*		Corsican pine transition to broadleaves
2	3	1	LP	90-100			x	x*			Lodgepole pine
2	3	2	LP	50-70	DBI	30-50	x	x*			Lodgepole pine and birch
2	4	1	LA	60-90	SP	10-40		x*			Larch and Scots pine
2	4	2	LA	60-80	XCST	20-40			x*	x	Larch and shade tolerant conifers
2	4	3	LA	50-80	BE	10-40			x*		Larch and beech
2	4	4	LA	50-70	OK	20-40				x*	Larch and oak
3	1	1	DF	90-100				x*			Douglas-fir
3	1	2	DF	80-90					x	x*	Douglas-fir LIMA/CCF
3	1	3	DF	60-80	XCST	20-40		x	x*	x	Douglas-fir and shade tolerant conifers
3	1	4	DF	70-90	XBLL	10-30		x	x*	x	Douglas-fir and broadleaves
3	2	1	PNWAF	90-100			x	x*			Pacific North-West American firs
3	2	2	PNWAF	80-90					x*	x	Pacific North-West American firs LIMA/CCF
3	2	3	PNWAF	50-70	XCST	30-50			x	x*	Pacific North-West American firs and XCST
3	2	4	PNWAF	60-80	SS	20-40	x	x*	x		Pacific North-West American firs and Sitka spruce

Index of FDT Flashcards – to be used in association with FDT management guide

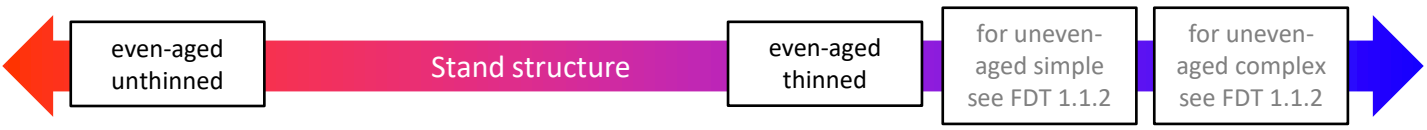
Individual Flashcards are presented in numerical order after the index.

FDT ID code			primary species	primary species proportion [%]	secondary species.	secondary species proportion [%]	Stand structure				Short title
							even-aged unthinned	even-aged thinned	uneven-aged simple	uneven-aged complex	
3	3-9		placeholder for any other Pacific North-West American conifers								
4	1-7		placeholder for any other shade tolerant conifers except spruces								
4	8	1	XCST	80-100			x	x	x*	x	Other shade tolerant conifers
4	9	1	XCLD	80-100				x*			Other light demanding conifers
5	1	1	POK	70-90	HBM	10-30			x*	x	Oak and hornbeam
5	2	1	SOK	50-80	BI	20-50		x	x	x*	Oak and birch
5	2	2	SOK	50-70	SP	20-40		x	x	x*	Oak and Scots pine
5	3	1	OK	60-80	BE	20-40			x*	x	Oak and beech
5	3	2	OK	50-70	XBLL	30-50			x	x*	Oak and long-lived broadleaves
5	3	3	OK	80-100	HAZ	n.a.			x*		Oak and hazel coppice
5	4-9		placeholder for other oak species								
6	1	1	BE	90-100			x	x*			Beech
6	1	2	BE	80-90					x	x*	Beech LIMA/CCF
6	1	3	BE	50-70	XCST	30-50			x	x*	Beech and shade tolerant conifers
6	1	4	BE	50-70	XBLL	30-50			x	x*	Beech and long-lived broadleaves
7	1	1	BI	70-100			x	x*			Birch
7	1	2	BI	50-70	XBSL	30-50	x	x*			Birch and short-lived broadleaves
7	2	1	SBI	60-90	SP	10-40		x	x*	x	Birch and Scots pine
7	2	2	SBI	50-80	SOK	20-50			x	x*	Birch and oak
8	1	1	SC	80-100					x	x*	Sweet chestnut coppice
8	1	2	SC	50-80	XBLL	20-50		x	x*	x	Sweet chestnut and long-lived broadleaves
8	2	1	AH	50-70	CAR	30-50			x	x*	Ash and alder
8	2	2	AH	50-70	XBLL	30-50				x*	Ash and long-lived broadleaves
8	3	1	SY	80-100				x	x*	x	Sycamore
8	3	2	SY	50-70	XBLL	30-50			x	x*	Sycamore and long-lived broadleaves
8	4	1	LI	50-90	XBLL	30-50		x	x	x*	Lime and long-lived broadleaves
8	5-9		placeholder for other long-lived broadleaved species								
9	1	1	CAR	80-100				x*			Alder
9	2-3		placeholder for other short-lived broadleaved species								
9	4	1	WIL	50-100			x			x	Willow
9	8	1	XBLL	30-100				x	x	x	Other long-lived broadleaves
9	8	2	XBLL	50-80	XC	20-50		x	x*	x	Long-lived broadleaves with conifers
9	9	1	XBSL	30-100			x	x			Other short-lived broadleaves
10	1	1	PEW								Peat edge woodland
10	1	2	SSW								Slope stabilisation woodland
10	2-9		placeholder for any other special FDTs								

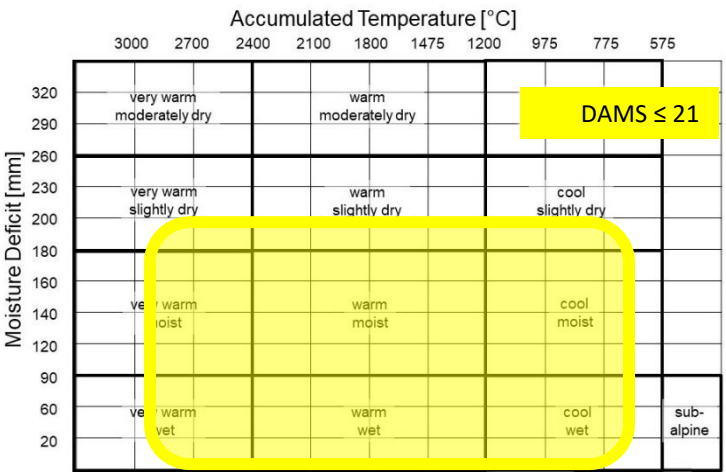
FDT 1.1.1 SS

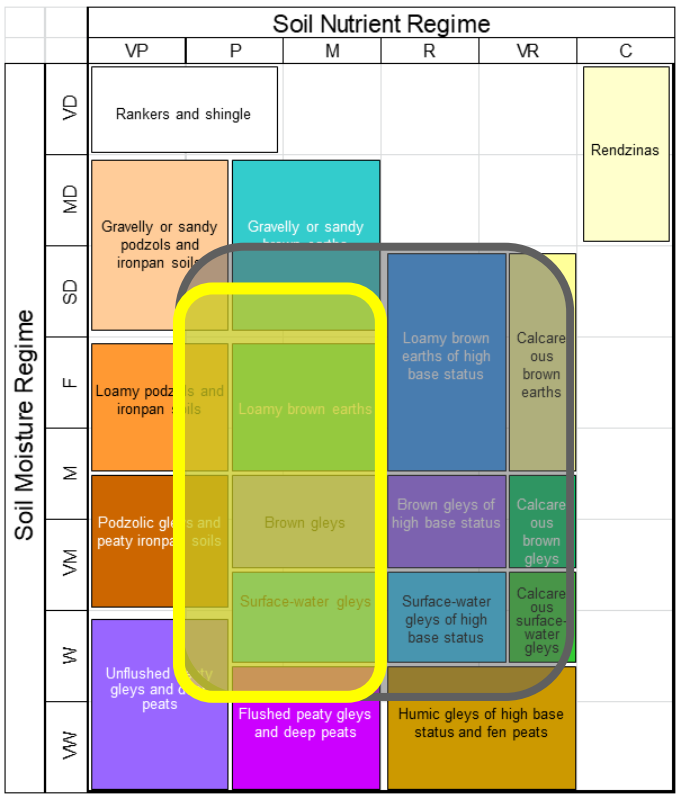


1. Structure and dynamics:
Single-storeyed SS stands with category A minor species, including remnants of nurse crops such as LP / SP.
Species distribution: SS 90 – 100% minor species: < 10%
Stands will largely be managed under clearfell-and-restock regime, with minor species regenerating naturally. Natural regeneration of SS should be used wherever practical.



2. Ecological suitability:
Represents no NVC type but provides niches for elements of W4, W17 and W18. Predominantly, but not exclusively, on exposed sites of poor fertility where SS is expected to grow below GYC 16 and options for LIMA / CCF are limited.





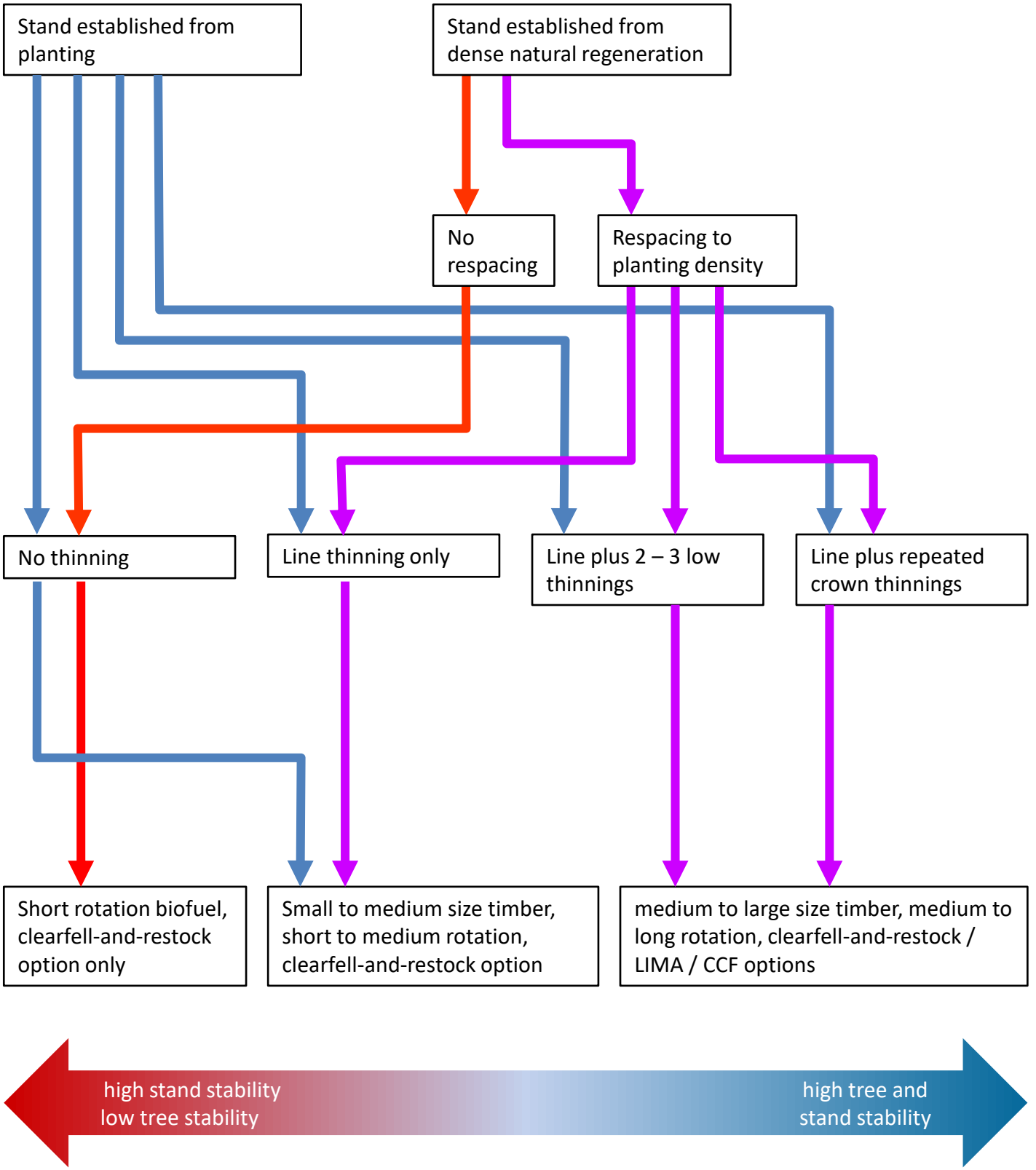
3. Management objectives:

Economic (GYC < 16):	SS – sawlogs / pulp / chip in 40 – 60yrs
Environmental and social:	Minor species elements increase habitat diversity and improve landscape value as well as stability and resilience with regard to risk factors over pure SS stands. In many upland areas these stands fulfil important roles in regulating water flow in catchment areas.

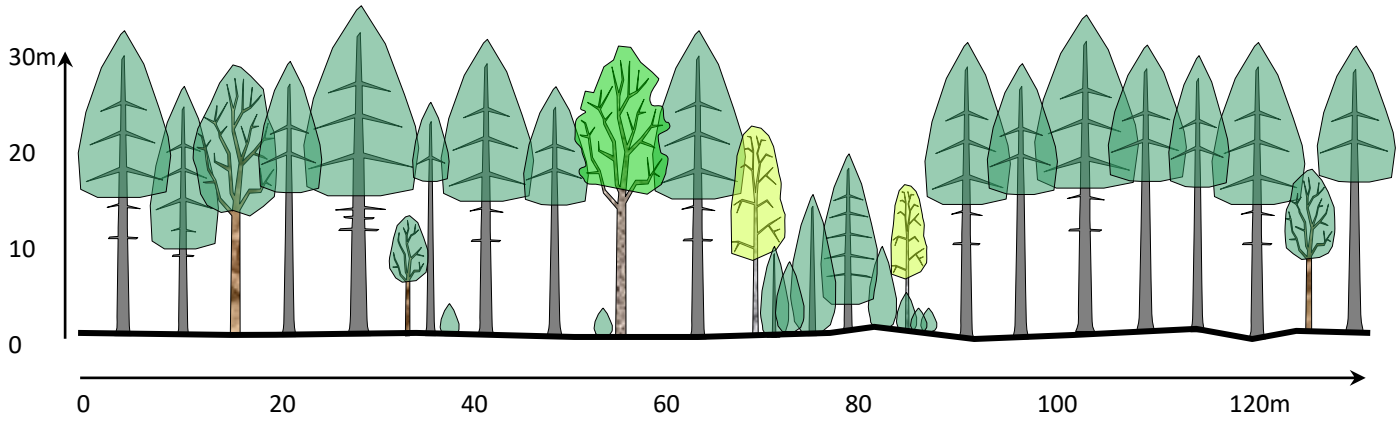
4. General management principles for the FDT

This FDT encompasses a wide range of options, including scenarios with limited or no thinning interventions, short rotation biomass production and scenarios which may result in LIMA or even CCF management. A general overview is given below; detailed guidance on management may be derived from other FDTs as appropriate.

5. Overview

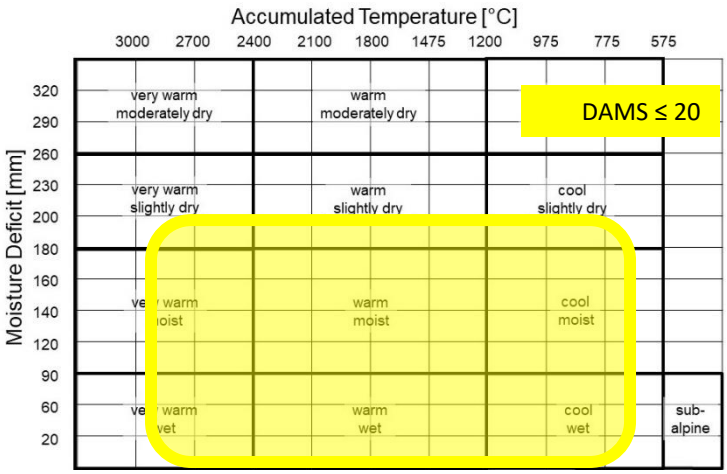


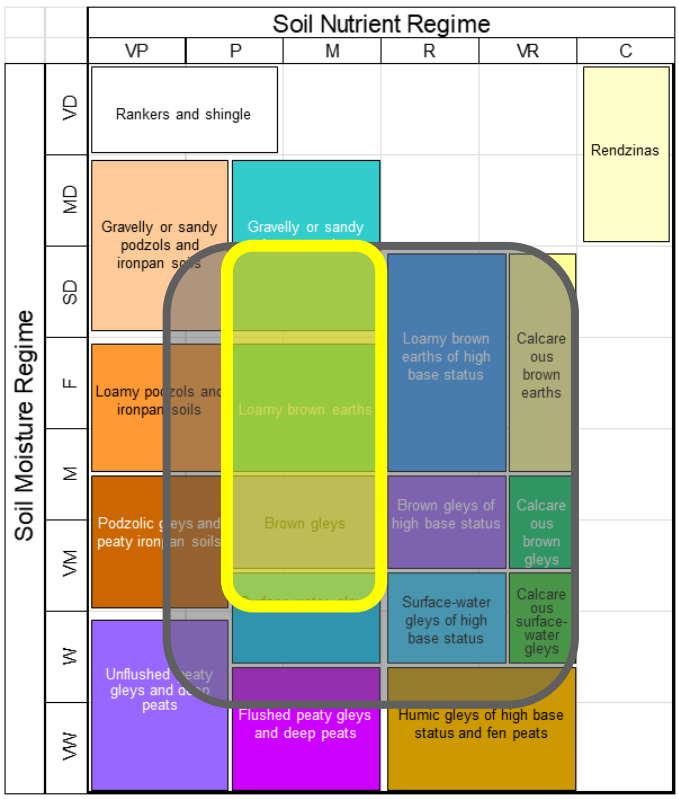
FDT 1.1.2 SS



1. Structure and dynamics:
Single to multiple-storeyed SS stands with category A minor species which are mixed in individually or in groups and mostly occupy suitable microsites and areas of difficult access.
Species distribution: SS 80 – 90% minor species: 10 – 20%
Stands are managed under LIMA / CCF regimes, with management aiming to create a diverse structure and using natural regeneration wherever practical.

2. Ecological suitability:
Represents no NVC type but provides niches for elements of W4, W7, W11 and W17. Suitable for more fertile soils (GYC > 14) where admixed species add to diversity and site productivity.





3. Management objectives:

Economic (GYC > 14):	SS – sawlogs, target DBH > 50cm in 60 – 100yrs
Environmental and social:	Mixed forest structure provides more diverse habitats for a range of species and improves stability with regard to risk factors over pure SS stands. Sustainable protection of water courses and option for CCF where exposure of forest soil by clearfelling is undesirable. High landscape and amenity value due to mixed components and more diverse stand structure.

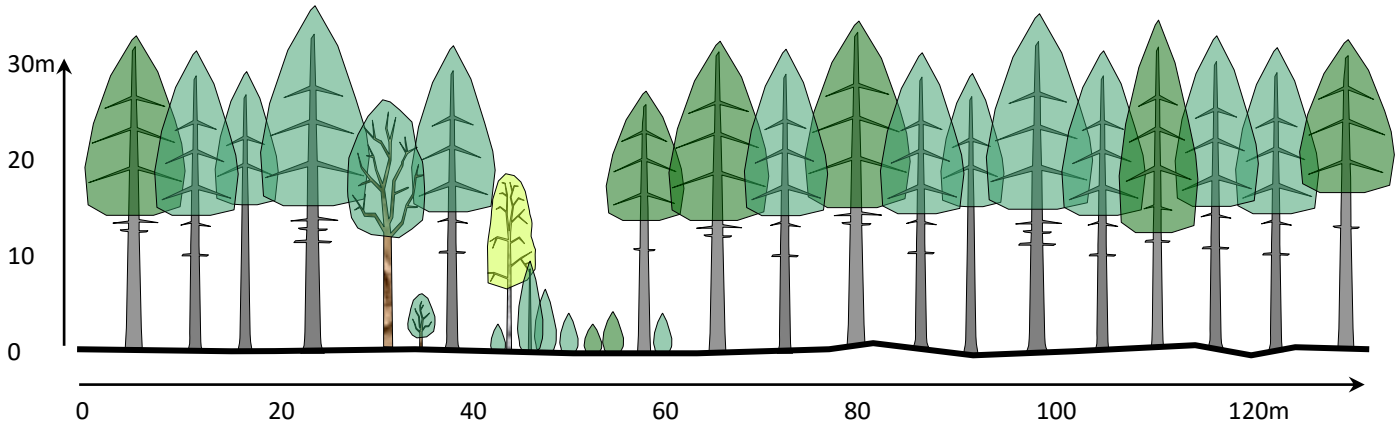
4. General management principles for the FDT

This FDT is for stands of SS growing on better sites than FDT 1.1.1 where there are more options for using LIMA / CCF. Target diameter harvesting and complex stand structures may be considered in sheltered conditions; simple structures and CCF management methods such as strip felling may be preferable on more exposed sites. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Dense natural regeneration of SS should be respaced so that no further interventions become necessary until the first thinning. Admixed species are to be promoted according to management objectives. SS will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Crown thinning should be used as long as necessary to develop good individual tree stability, however the thinning type may eventually shift towards low thinning, particularly in areas of high wind risk. Final harvesting should be accompanied by establishment and differentiation of natural regeneration.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (optional).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when dominant / FC trees approach target DBH. • Decide on LIMA / CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • In shelterwood scenarios, reduce BA to 30m^2/ha initially, and then further once regeneration has established. • Design strip systems with regard to prevailing wind direction and climatic requirements of SS regeneration; keep strip width < 50m. • Monitor light level, seedbed conditions, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 1.1.3 SS and DF

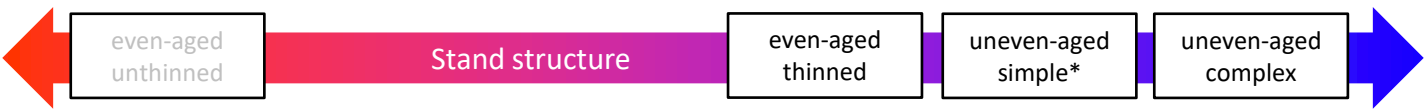


1. Structure and dynamics:

Mixed stands of SS with DF as compatible secondary species. Stands may be even-aged and single storied, or develop into a complex structure. Species are mixed intimately, in small or large groups, or in patches. Supplemented by minor species of category A.

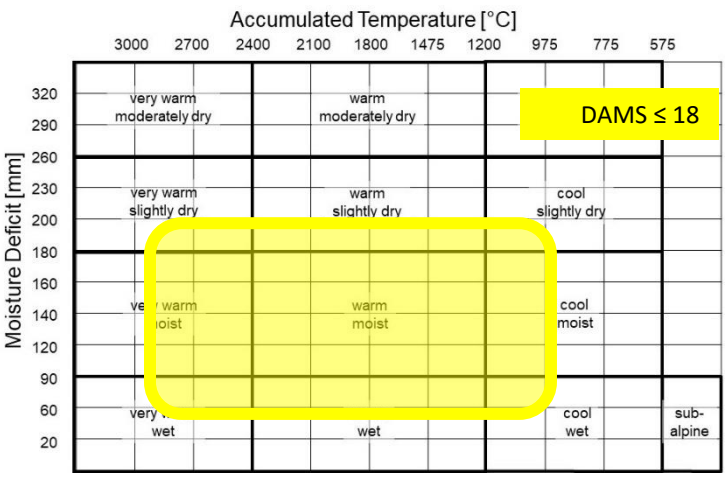
Species distribution: SS 60 – 80% DF 20 – 40% minor species: < 10%

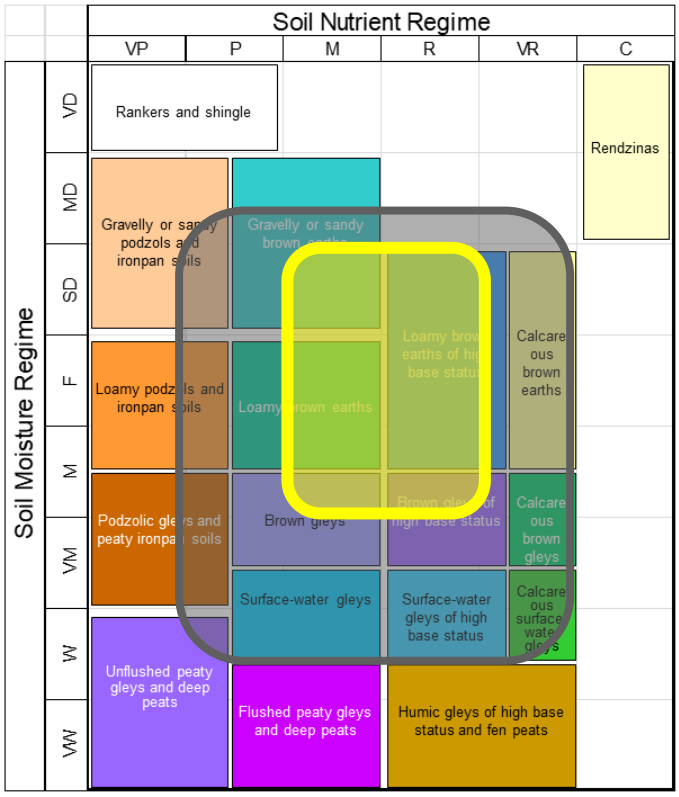
Management is likely to be by clearfelling and restocking at variable scale, or by LIMA / CCF, making use of natural regeneration wherever practical.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of W11, W17, W10 and W14. Appropriate on freely draining higher quality sites with loamy soil texture where SS GYC > 18 and DF provides added value for timber production.





3. Management objectives:

Economic:	SS – sawlogs, target DBH > 50cm in 60 – 100yrs DF – sawlogs, target DBH > 70cm in 80 – 100yrs
Environmental and social:	Increased habitat diversity and better maintenance of soil quality compared to pure stands. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation.

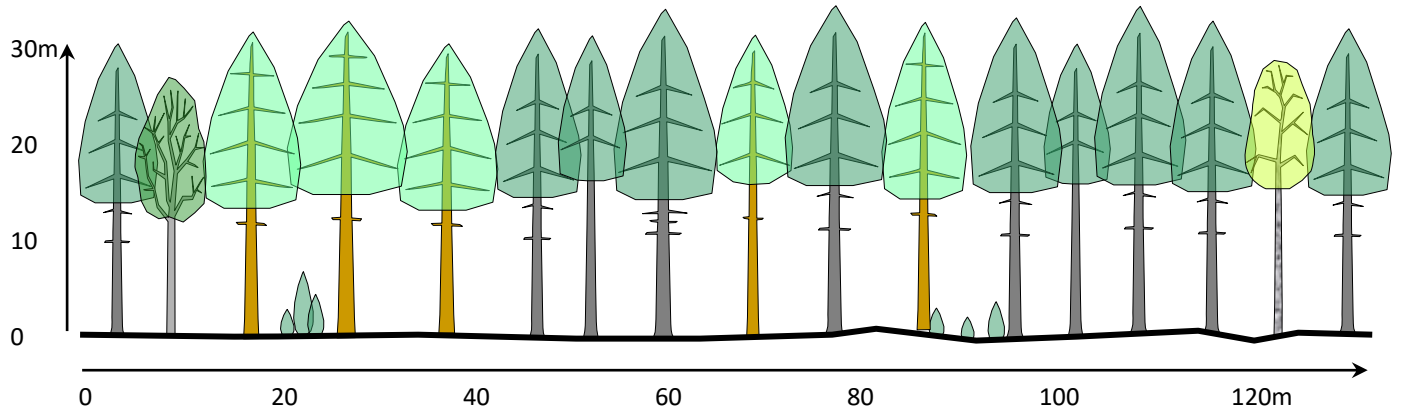
4. General management principles for the FDT

This FDT should be used where SS is planted on better soils and DF is a desirable species. SS and DF have similar shade tolerance and growth rate and are compatible to grow in mixture (CS = 1). Management of young stands should aim to secure DF if there is profuse natural regeneration of SS; this may require (repeated) respacing. Both species will respond well to thinning throughout their lifetime, however thinning must not be unduly delayed in order to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration. Site requirements of natural regeneration differ slightly between the species; in general DF will benefit from drier, warmer and more sheltered conditions compared with SS.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha according to target species proportion, or natural regeneration with supplementary planting where necessary.
Young stand	< 3	• Protection against animals / plants as necessary. • Natural regeneration with N > 3000 trees/ha requires respacing at 1 – 2m tree height. Respacing is also used to steer species proportion and clear damage caused by felling / extraction of overstorey trees. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Infill of < 10% minor species is to be accepted / promoted for diversity.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing undesirable dominant and co-dominant trees (e.g. forks and coarsely branched trees). • Selection of 150 – 250 FC trees/ha (SS + DF). • Pruning of DF FC trees may be considered.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • In shelterwood scenarios, reduce BA to 30m²/ha initially and then further once regeneration has established. • Design strip systems with regard to prevailing wind direction and climatic requirements of DF / SS regeneration; keep strip width < 50m. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.1.4 SS and light demanding conifers (XCLD)

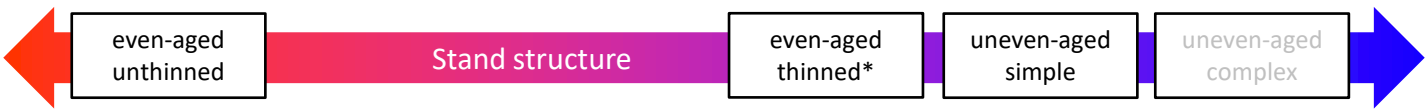


1. Structure and dynamics:

Mixed stands of SS with XCLD (larches or pines), often established as a nursing mixture. Stands are usually even-aged and single storied but may develop into a complex structure if managed accordingly. Species may be mixed intimately, in groups, or in patches. Supplemented by minor species of category A.

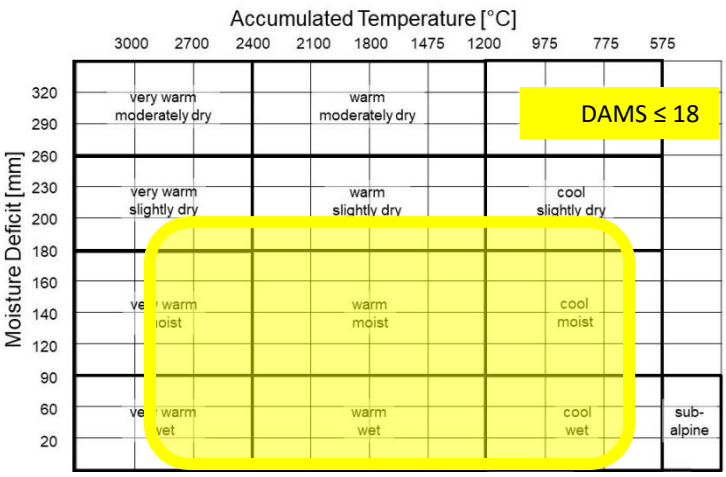
Species distribution: SS 60 – 80% XCLD 20 – 40% minor species: < 10%

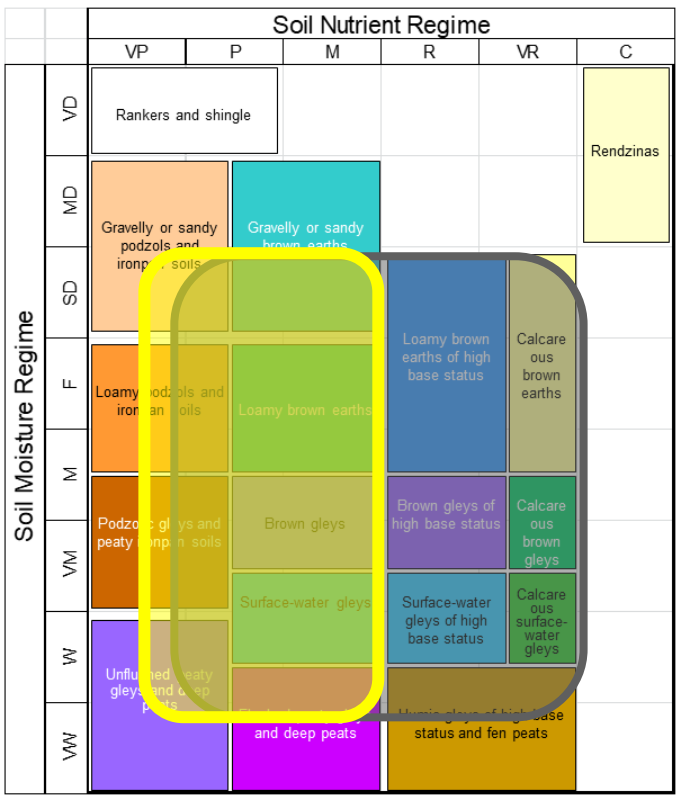
Management is likely to be by clearfelling and restocking, or by LIMA / CCF, making use of natural regeneration wherever practical.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of W18, W17, W11 and W4. The choice of XCLD species must reflect soil conditions – SP on poorer and drier soils, LP on wet ground and larches on the most fertile sites.





3. Management objectives:

Economic: SS – sawlogs / pulp / chip in 40 – 60yrs
XCLD – sawlogs / pulp / chip in 40 – 80yrs

Environmental and social: Mixed forest structure provides more diverse habitats for a range of species, higher landscape and amenity value, improves soil quality and stability with regard to risk factors over pure SS stands. Option for CCF where exposure of forest soil by clearfelling is undesirable.

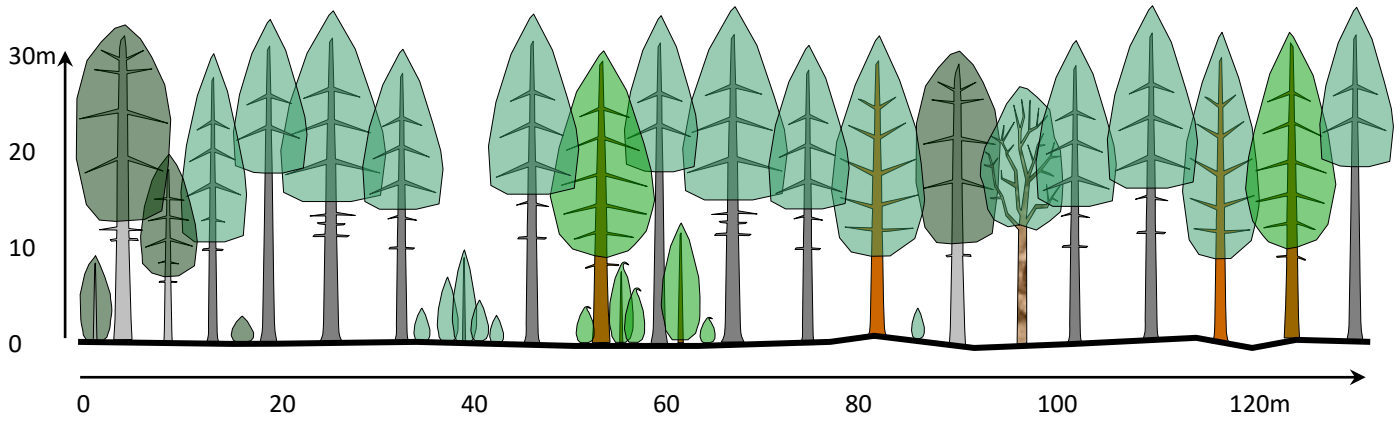
4. General management principles for the FDT

This FDT may be difficult to perpetuate because of the compatibility of the species, more so for SP and LP (CS = 4) than JL or HL (CS = 2). Management of young stands must aim to develop vigour and stability of individual trees. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. Whereas SS responds well to thinning throughout its lifetime the response of XCLD will fade over time and efforts to induce diameter growth must therefore focus on early interventions. These stands will often have been established as self-thinning mixtures – a no thinning approach is therefore possible but will limit management options and achievable target DBH. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. XCLD must be promoted over SS in order to ensure their position in the canopy. XCLD may be managed on a longer rotation than SS, stability permitting. In that case a two-storey CCF structure may develop, otherwise restocking after clearfell is envisaged. In general, natural regeneration of XCLD will be more difficult to achieve than of SS, so supplementary planting may be required and this will need to be secured if SS regeneration is dense.

5. Timeline

stage	H_{100} [m]	Intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • XCLD may be planted as nurse, in rows or alternating with SS.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Steering of SS / XCLD proportion in natural regeneration, promotion of minor species as required. XCLD proportion in natural regeneration should be at least 10% higher than final target.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. Promote XCLD over SS. • Selection of 150 – 250 FC trees/ha (SS + XCLD).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, favouring XCLD. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Assess potential for natural regeneration and consider LIMA / CCF options.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • If XCLD is managed on a longer rotation than SS monitor seedbed conditions, occurrence and growth rate of regeneration. Supplement by planting and review FDT if difficult to sustain XCLD.

FDT 1.1.5 SS and shade tolerant conifers (XCST)

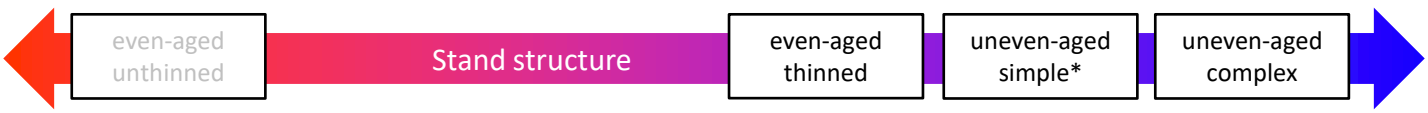


1. Structure and dynamics:

Mixed stands of SS and one or several XCST species, likely to include WH, firs, WRC and others. Stands may be even-aged and single storied, or develop into a complex structure. Species may be mixed intimately, in small or large groups, or in patches. Supplemented by minor species of category A.

Species distribution: SS 60 – 80% XCST 20 – 40% minor species: < 10%

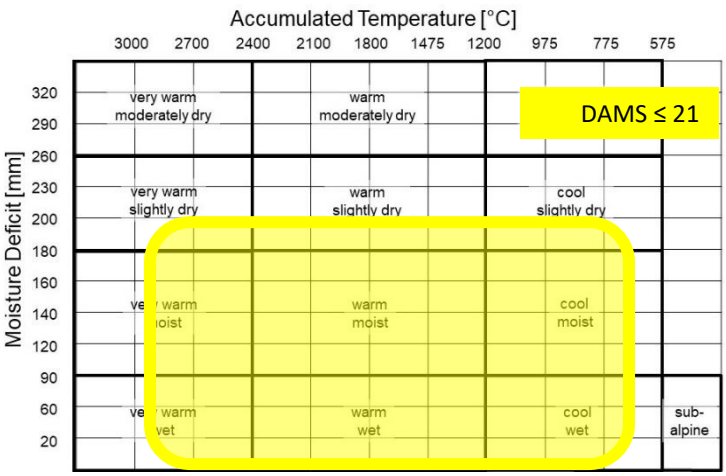
Management is likely to be by clearfelling and restocking at variable scale, or by LIMA / CCF.

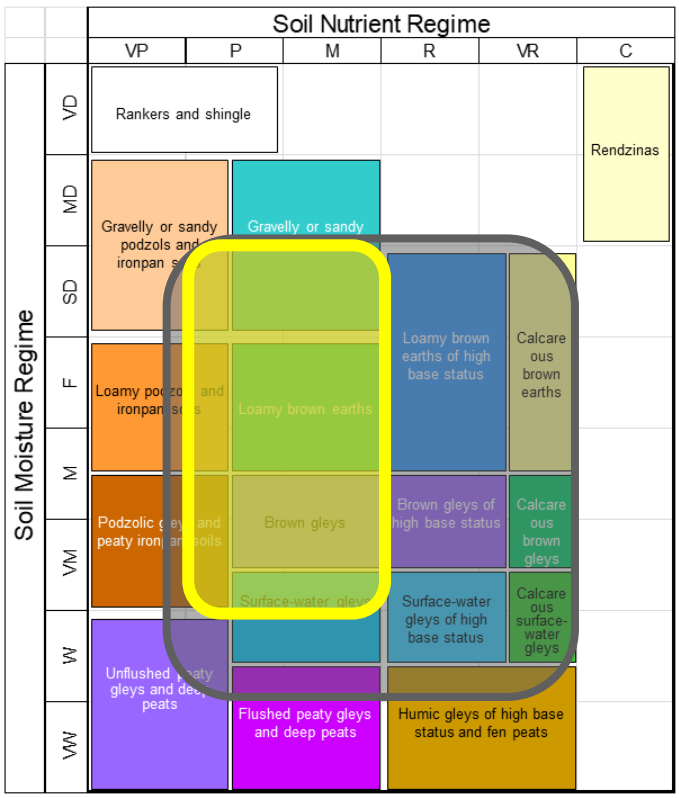


2. Ecological suitability:

Represents no NVC type but provides niches for elements of W4, W11, W17, W10 and W15.

Appropriate on freely draining to wet sites of medium fertility with loamy soil texture where SS achieves GYC > 12.





3. Management objectives:

Economic: SS – sawlogs, target DBH > 40cm in 60 – 100yrs
XCST – sawlogs, target DBH > 40cm in 60 – 100yrs

Environmental and social: Increased habitat diversity, stand stability and maintenance of soil quality compared to pure stands. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation. Offers opportunities to introduce emerging species.

FDT 1.1.5 SS and shade tolerant conifers (XCST)

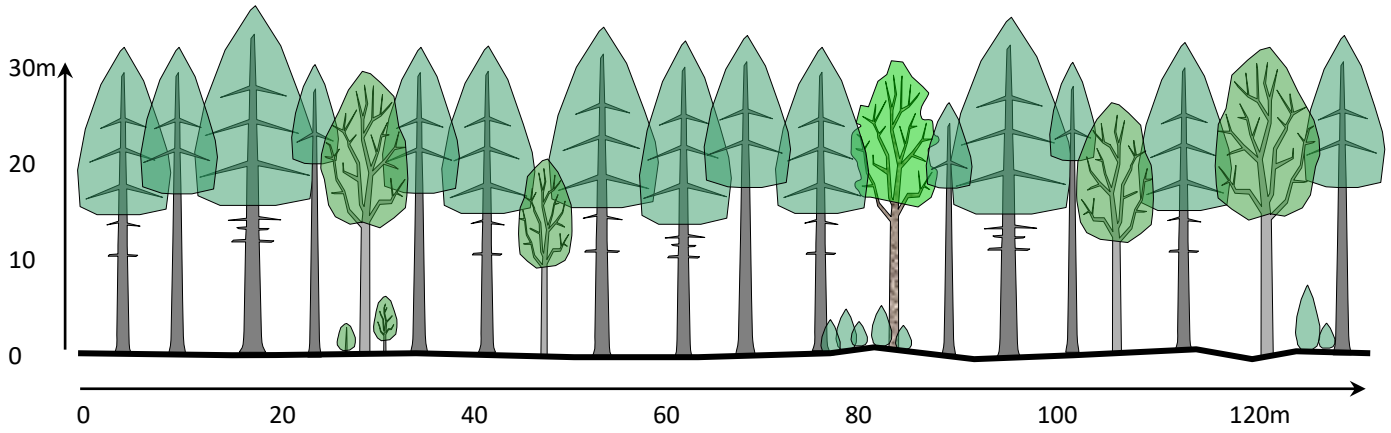
4. General management principles for the FDT

This FDT is appropriate on a wide variety of sites where objectives require the presence of a shade tolerant secondary species. Mixtures are generally compatible (CS = 1 or 2 depending on XCST) with the fast growth rate of SS being compensated by the greater shade tolerance of XCST. Management of young stands should be similar to FDT 1.1.2 and must aim to secure XCST if there is profuse natural regeneration of SS, possibly requiring (repeated) respacing. All species involved will respond well to thinning throughout their lifetime, however thinning must not be unduly delayed in order to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration as many XCST may struggle to establish under open ground conditions. Any planted XCST will need to be secured if natural regeneration of SS is profuse.

5. Timeline

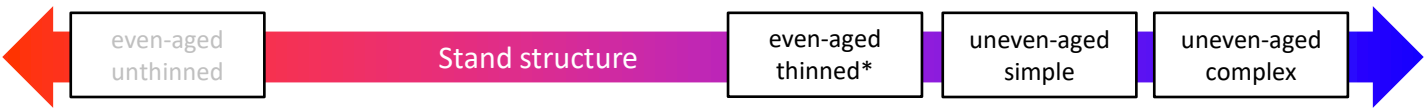
stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration • XCST may be planted as beat-up or to supplement natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Steering of SS / XCST proportion in natural regeneration, promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SS + XCST).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. • In shelterwood scenarios, reduce BA to 35 – 40m^2/ha initially and then further once regeneration has established. Lower BA values will benefit natural regeneration of SS, higher ones XCST. • Design strip systems with regard to prevailing wind direction and climatic requirements of XCST / SS regeneration; keep strip width < 50m. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.1.6 SS and BE



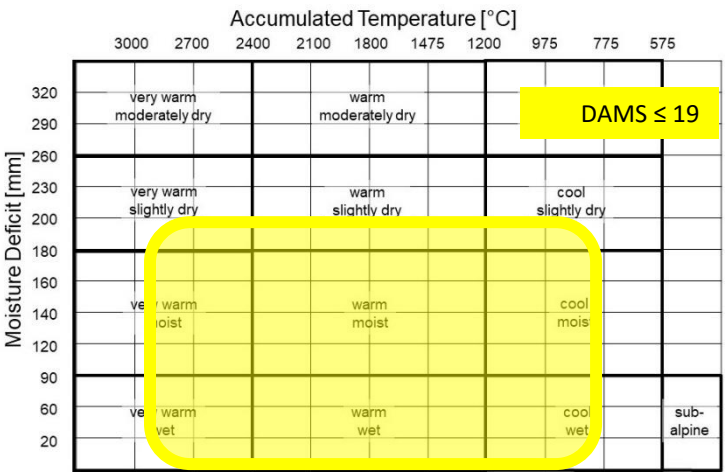
1. Structure and dynamics:

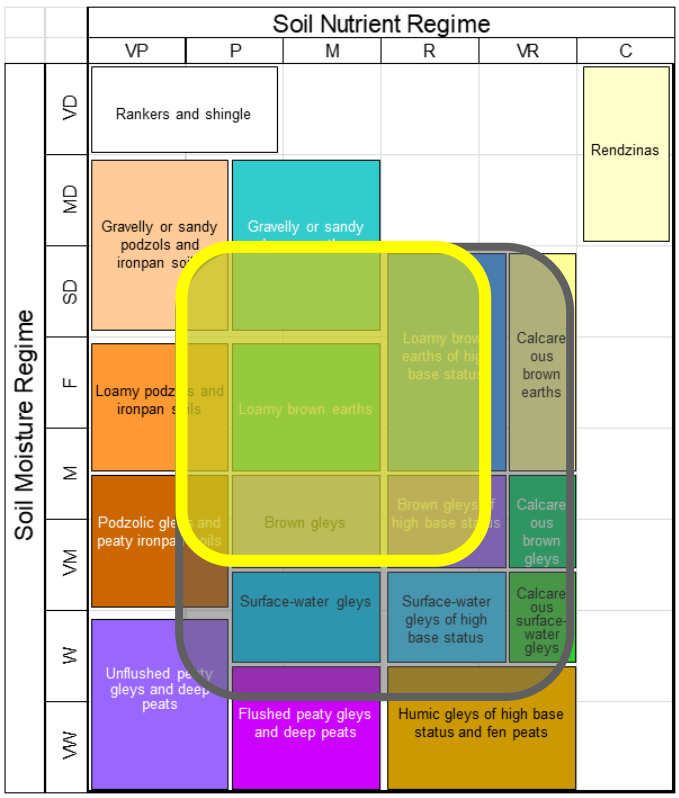
Mixed stands of dominating SS interspersed with BE, which may be single storied or develop into a complex structure. Species may be mixed intimately or in small groups. Minor species of category A.
Species distribution: SS 70 – 90% BE 10 – 30% minor species: < 10%
Management is likely to be by LIMA / CCF, with BE adding to diversity, stand stability and facilitating favourable conditions for natural regeneration.



2. Ecological suitability:

BE component represents parts of NVC type W15, also provides niches for elements of W11, W17, W10 and W16. Appropriate on freely draining sites of medium fertility with loamy soil texture where SS achieves GYC > 12.





3. Management objectives:

Economic: SS – sawlogs, target DBH > 40cm in 60 – 100yrs
BE – optional

Environmental and social: Inclusion of BE element improves soil quality compared to a pure SS stand and increases biodiversity value and stand stability. The mixed-species and potentially diverse age structure of the stand is likely to be attractive (autumn and spring aspect) and popular for amenity and recreation.

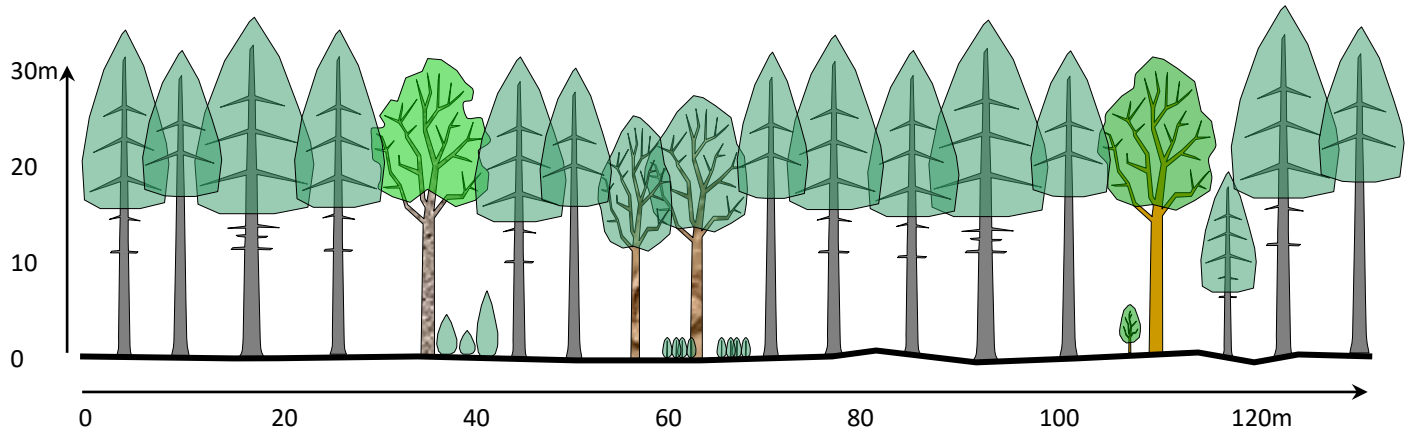
4. General management principles for the FDT

The role of BE in this FDT is mainly for environmental and social benefits, however economic opportunities arising from biomass / timber production should be used wherever possible. Both species are generally compatible (CS = 2); the faster growth rate and taller final height of SS are compensated by the higher shade tolerance of BE. Most stands are therefore likely to develop two distinct canopy layers over time. Management of young stands must aim to develop vigour (BE) and stability (SS) of individual trees. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. Both species will respond well to thinning throughout their lifetime but in order to maintain good tree stability of SS thinning must not be unduly delayed. Thinning of SS should start at around 10 – 12m top height, generally as crown thinning. Thinning of BE should aim to produce vigorous and stable trees, some of which may be kept beyond SS rotation for their environmental benefits. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • BE should be planted in small groups (< 0.03ha) if sawlog production is envisaged, otherwise mixed in individually or in rows.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing of SS if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing of dense BE regeneration (wolf trees). • Release 300 – 400 SS FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SS + BE).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • Thinning in groups of BE suitable for timber production should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Assess potential for natural regeneration and consider LIMA / CCF options.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Retain a proportion of stable BE beyond SS rotation as seed trees and for vegetation control. • Use natural regeneration where practical, otherwise restock by planting.

FDT 1.1.7 SS and long-lived broadleaves (XBLL)

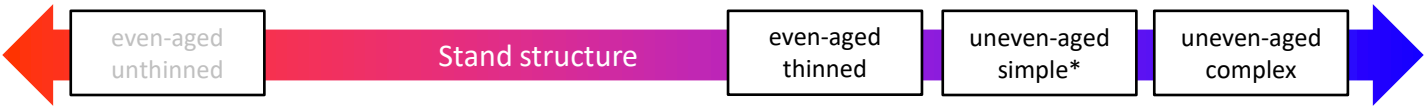


1. Structure and dynamics:

Mixed stands of dominating SS interspersed with XBLL, even-aged and single storied or developing into a complex structure. XBLL are likely to include OK, SY, AH, AR and others. Species may be mixed in small or large groups, depending on light requirements and microsite conditions. Category A minor species.

Species distribution: SS 50 – 90% XBLL 10 – 50% minor species: < 10%

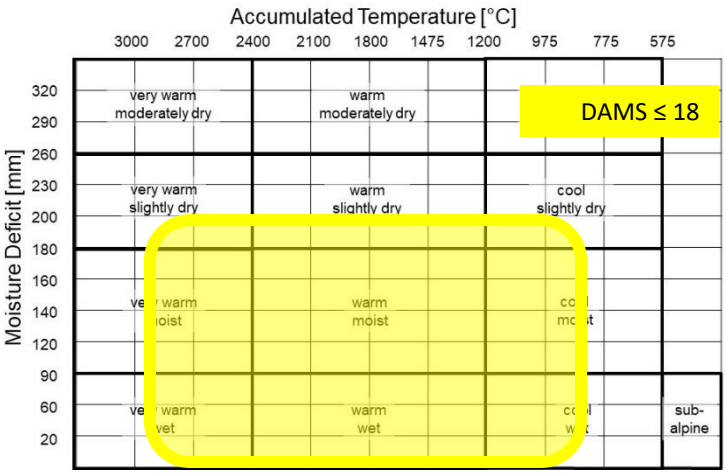
Management is likely to be by LIMA / CCF, making use of natural regeneration wherever possible.

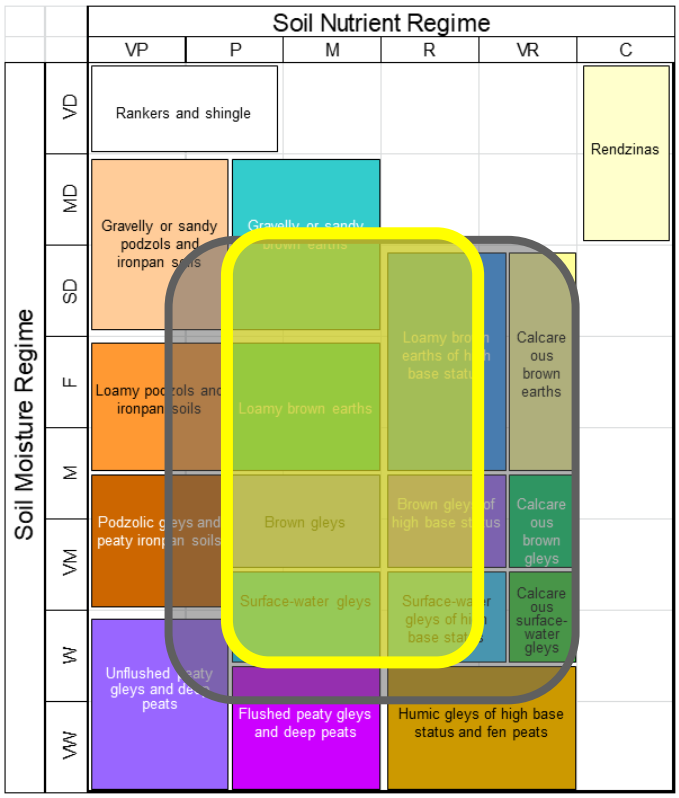


2. Ecological suitability:

XBLL component represents parts of various NVC types with complementary minor species.

Appropriate on sites of moderate fertility, with loamy soil texture, and variable soil moisture, where SS achieves GYC > 16.





3. Management objectives:

Economic:	SS – sawlogs, target DBH > 50cm in 60 – 100yrs XBLL – optional
Environmental and social:	Inclusion of XBLL element is expected to better maintain soil quality compared to a pure SS stand, increase biodiversity value and stand stability. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation.

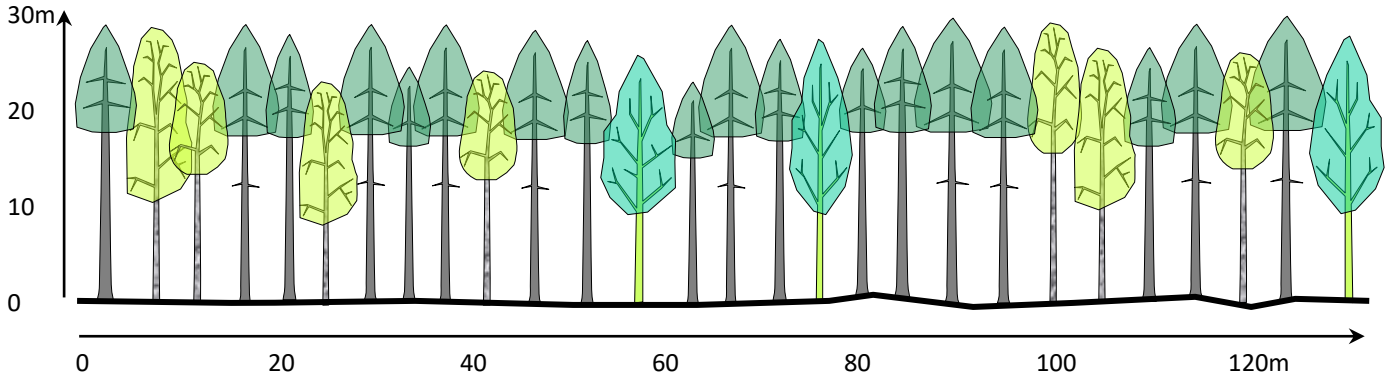
4. General management principles for the FDT

Compatibility of the FDT components varies with XBLL species (CS = 3 for OK, CS = 1 for AH and SY). The fast growth rate and taller final height of SS should therefore be compensated by the positioning of XBLL in groups, which will also benefit timber quality. Some species such as CAR may be separated from SS by microsite conditions. Management of young stands must aim to develop vigour (XBLL) and stability (SS) of individual trees. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. SS will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed and should start at around 10 – 12m top height, generally as crown thinning. Thinning of XBLL must aim to develop and maintain large crowns early on, aiming to produce vigorous and stable trees which are able to maintain their position within a SS dominated canopy. XBLL are likely to be managed on a longer rotation than SS, hence LIMA / CCF methods are the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • XBLL should be planted in robust groups or rows depending on the compatibility of XBLL species and envisaged production targets.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing of SS if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing of dense XBLL regeneration. • Release 300 – 400 SS FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SS + XBLL).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between SS and XBLL and adjust thinning accordingly. • Thinning in groups of XBLL suitable for timber production should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to suitable LIMA / CCF method; adjust for XBLL species specific requirements. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.1.8 SS and short-lived broadleaves (XBSL)

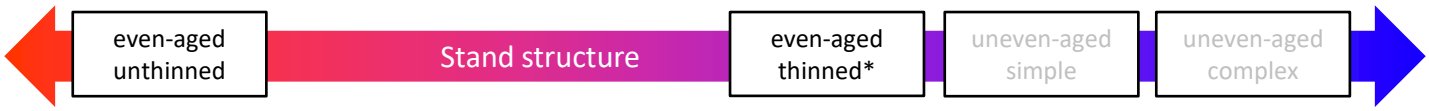


1. Structure and dynamics:

Even-aged, single storied stands of SS interspersed with XBSL. Likely to have originated from XBSL infill in SS plantation, mainly with BI, WIL, ASP, ROW. Minor species may also include any others of category A.

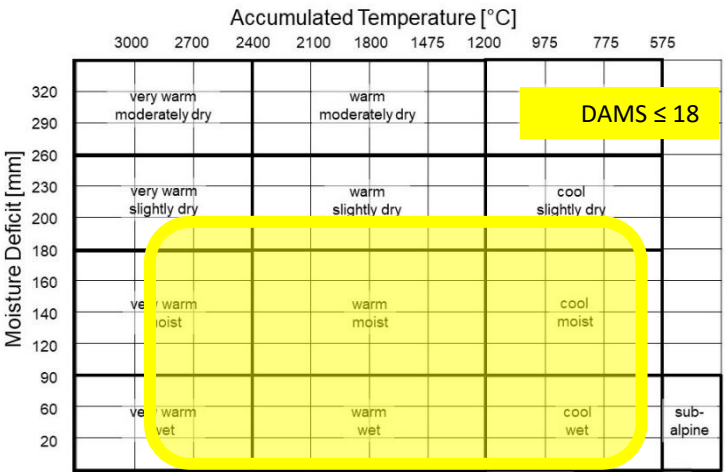
Species distribution: SS 50 – 90% XBSL 10 – 50% minor species: < 10%

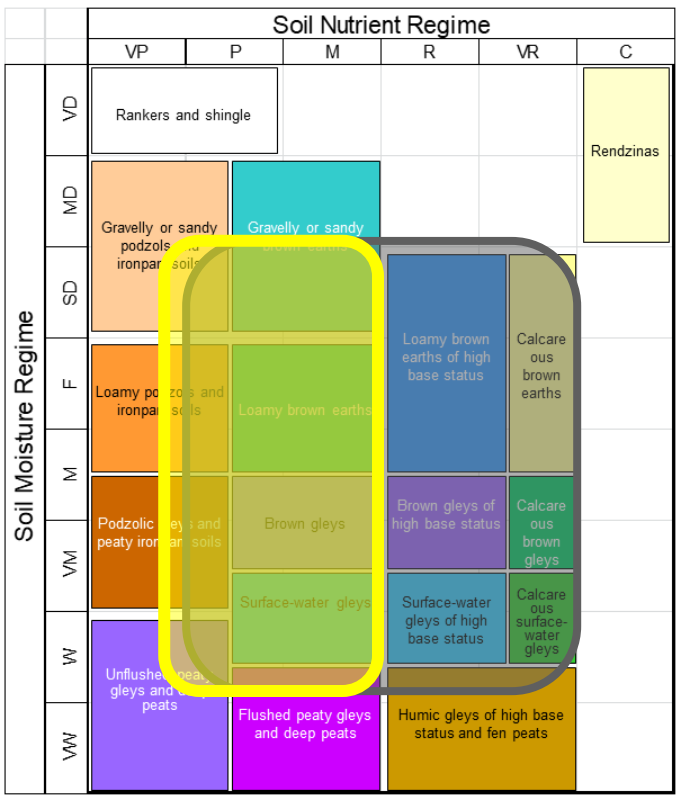
The XBSL component will often be the result of SS having partially failed at restocking. Thus, the reasons for failure need to be established in order to avoid recurrence. Transformation to another FDT may be considered, otherwise stands will largely be managed under a clearfell-and-restock regime.



2. Ecological suitability:

XBSL component represents parts of NVC type W4. May be considered transition stage. Likely to occur on a wide range of sites, usually of lower fertility.





3. Management objectives:

Economic:	SS – sawlogs / pulp / chip in 40 – 60yrs XBSL – optional
Environmental and social:	Inclusion of XBSL element will better maintain soil quality compared to a pure SS stand and will also increase biodiversity value. The mixed character of the stand is likely to be attractive and popular for amenity and recreation.

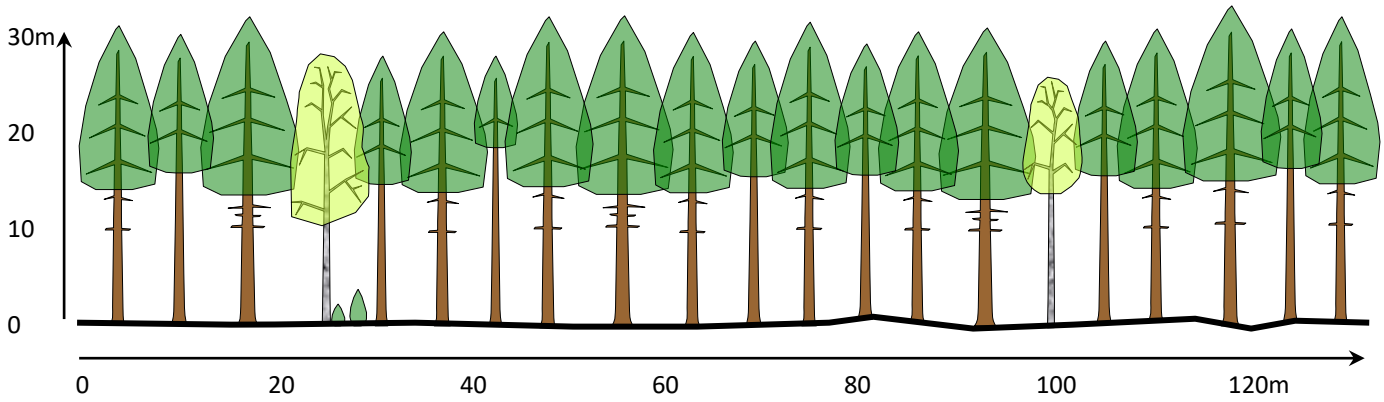
4. General management principles for the FDT

The role of XBSL in this FDT is mainly for environmental and social benefits, however economic opportunities arising from biomass / timber production should be used wherever possible. Most XBSL will be able to keep up with SS growth rate for some time (especially on less fertile sites) but essentially this FDT is confined to shorter rotation lengths. Management of young stands should aim to achieve canopy cover and maintain even growth of all stand components. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability, which is essential for retaining thinning options. A no thinning approach is possible but will limit management options and achievable target DBH. SS will respond well to thinning throughout its lifetime but the thinning of XBSL should focus on early interventions. Thinning should start at around 10 – 12m top height, generally as crown thinning. Thinning should aim to maintain species composition and canopy cover. Review of FDT at time of final harvesting if the current stand has resulted from XBSL infill on a SS restock site.

5. Timeline

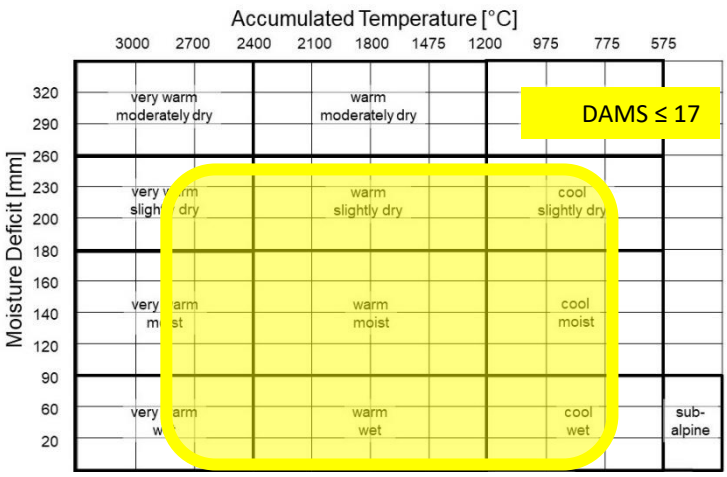
stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha, XBSL often from natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions; except for pre-selection of high quality XBSL stems if sawlog production is envisaged.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SS + XBSL, optional).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor crown length and h/d ratio in SS (stability indicators), species composition, height growth and canopy cover in SS and XBSL (competition indicators) and thin accordingly. • Apply crown thinning as long as necessary for benefits of FC trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when dominant / FC trees approach target DBH. • Assess potential for natural regeneration and improve conditions if necessary, review suitability of FDT and consider LIMA / CCF methods as appropriate.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

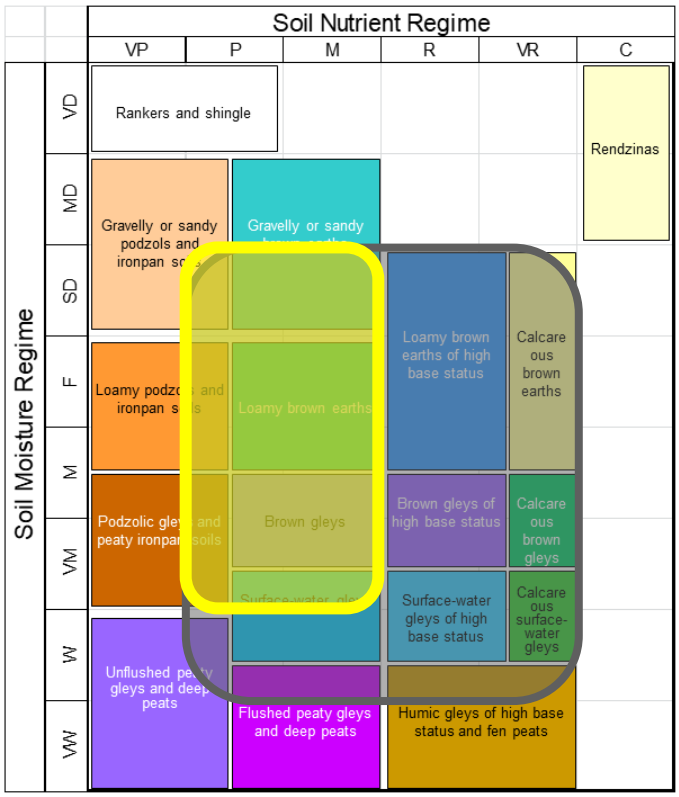
FDT 1.2.1 NS



1. Structure and dynamics:
Single-storeyed NS stands with category A minor species, mixed individually or in groups on microsites unsuitable for NS.
Species distribution: NS 90 – 100% minor species: < 10%
Stands will largely be managed under clearfell-and-restock regime, with minor species regenerating naturally. Natural regeneration of NS should be used wherever possible, and CCF / LIMA options may be a practical alternative to clearfelling.

2. Ecological suitability:
Represents no NVC type but provides niches for elements of W4, W17 and W18. Predominantly, but not exclusively, on exposed sites of poor fertility where NS is expected to grow below GYC 14 and options for CCF are limited.





3. Management objectives:

Economic (GYC < 14):	NS – sawlogs / pulp / chip in 70 – 120yrs
Environmental and social:	NS is one of the main habitat species for red squirrels. Minor species elements increase habitat diversity and improve amenity aspects as well as stability and resilience with regard to risk factors over pure NS stands.

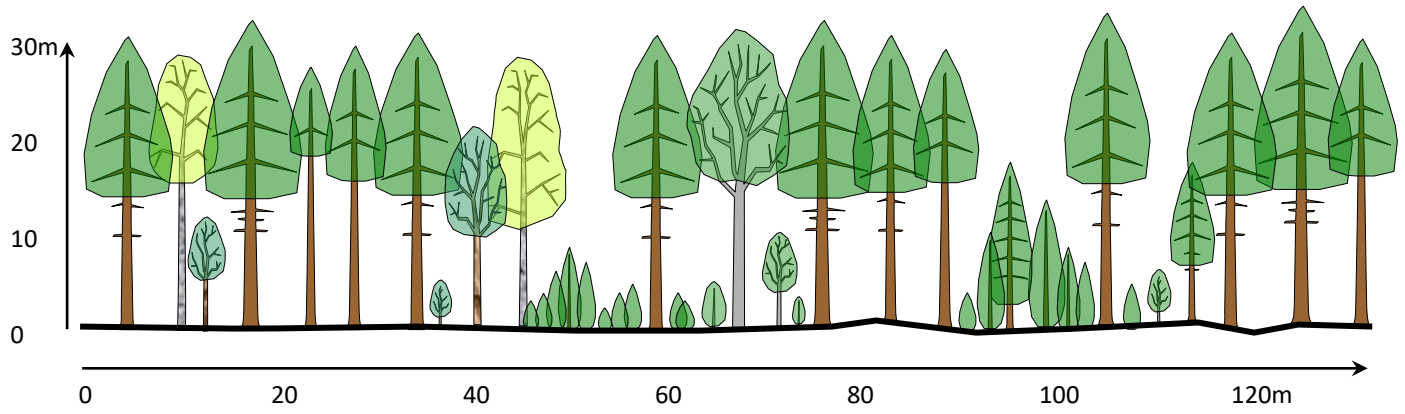
4. General management principles for the FDT

This FDT should be used where clearfell-and-restock scenarios with NS are envisaged, either because this suits the site specific management objectives or because sufficient natural regeneration of NS cannot be expected. In the latter case a review of the FDT may be required. Management of young stands should aim to achieve canopy cover and maintain even and rapid growth of all stand components. Developing good tree stability is also important if the stand is to be thinned. A no thinning approach is possible but will limit management options and achievable target DBH. Rare stands originating from dense natural regeneration are likely to require respacing. NS will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Thinning at later stages should aim to maintain an even canopy cover; with thinning type changing to low.

5. Timeline

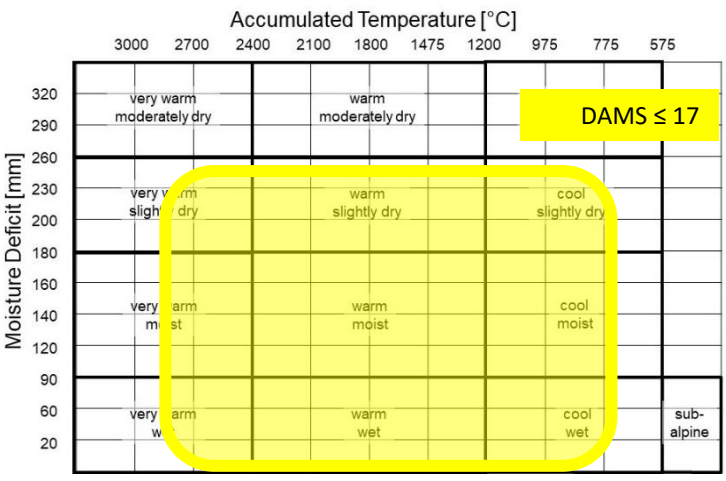
stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if the stand is to be thinned and respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (optional).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor crown length, h/d ratio (stability indicators), BA and canopy cover (competition indicators) and thin accordingly. • Apply crown thinning as long as necessary for benefits of FC trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when dominant / FC trees approach target DBH. • NS is unlikely to regenerate naturally, however, opportunities to take advantage of natural regeneration may arise on longer rotations and should be used where practical.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

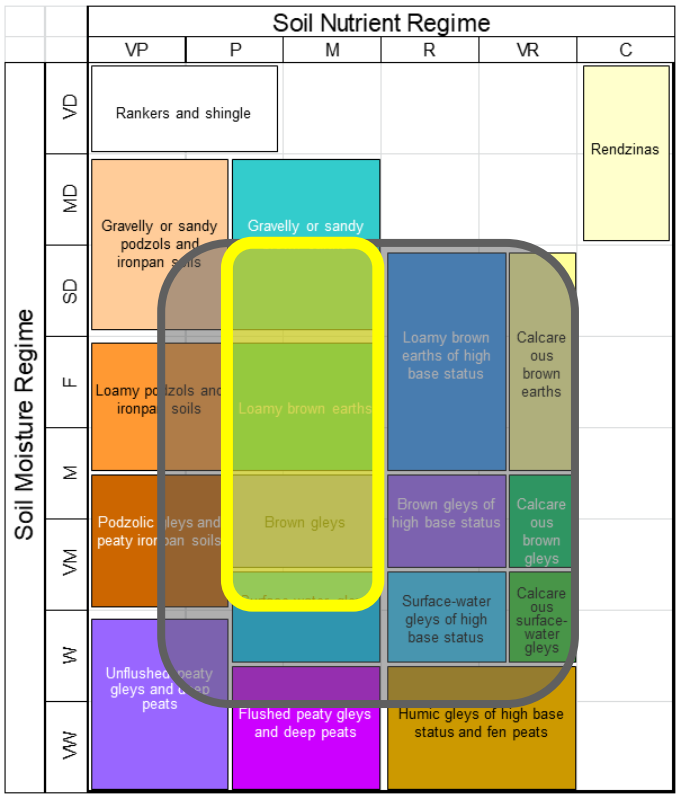
FDT 1.2.2 NS



1. Structure and dynamics:
Single to multiple-storeyed NS stands with category A minor species, admixed individually or in groups, mostly occupying suitable microsites and areas of difficult access.
Species distribution: NS 80 – 90% minor species: 10 – 20%
Stands may be managed under small scale clearfell-and-restock (LIMA) or CCF regimes, with management aiming to create a complex stand structure. Natural regeneration is to be used wherever possible and should account for the majority of NS and minor species component.

2. Ecological suitability:
Resembles NS-dominated natural woodland communities of central European mountain regions. Represents no NVC type but provides niches for elements of W4, W11, W15, W16 and W17. Suitable for freely draining to slightly gleyed soils of medium fertility and loamy texture.





3. Management objectives:

Economic (GYC > 12):	NS – sawlogs, target DBH > 50cm in 80 – 120yrs
Environmental and social:	Uneven-aged forest structure provides habitats for a range of species (red squirrel) and lends itself to low-impact management. Structural and species diversity improve stability with regard to risk factors over pure NS stands. Minor species contribute to maintaining soil fertility. High landscape and amenity value due to mixed components and more diverse stand structure.

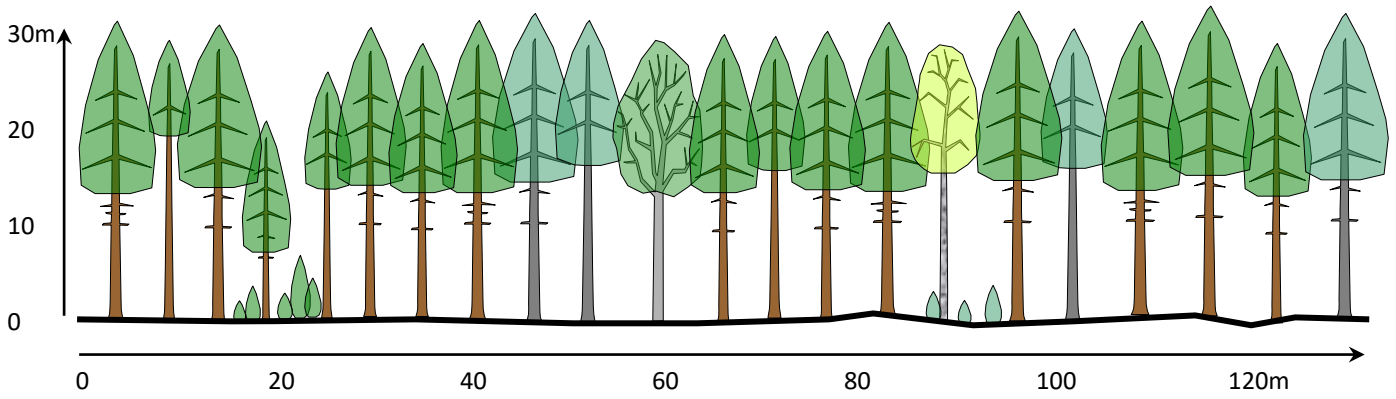
4. General management principles for the FDT

This FDT is for stands of NS growing on better sites compared to FDT 1.2.1 and where more structural diversity can be achieved by use of LIMA / CCF. Natural regeneration of NS is often difficult to achieve and requires a long enough rotation as well as careful silvicultural practice in order to create suitable site conditions. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Dense natural regeneration of NS is rare but will require respacing if it occurs. NS will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Crown thinning should be used as long as necessary to develop good individual tree stability, however the thinning type may eventually shift towards low thinning, particularly in areas of high wind risk. Final harvesting should be accompanied by establishment and differentiation of natural regeneration. Target diameter harvesting and complex stand structures may be considered in the most sheltered conditions; simple structures and CCF methods such as shelterwood systems may be preferable on more exposed sites.

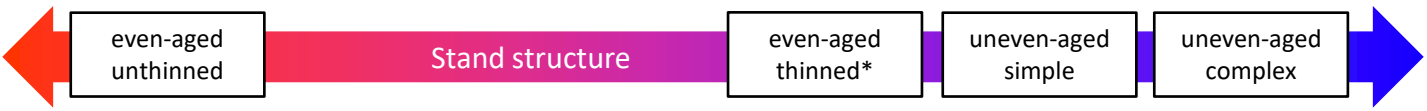
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method (simple or complex) to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method, time with mast years if possible. • In shelterwood scenarios, reduce BA to 35m^2/ha initially and then further once regeneration has established (usually at ages > 80yrs). • For complex scenarios, interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

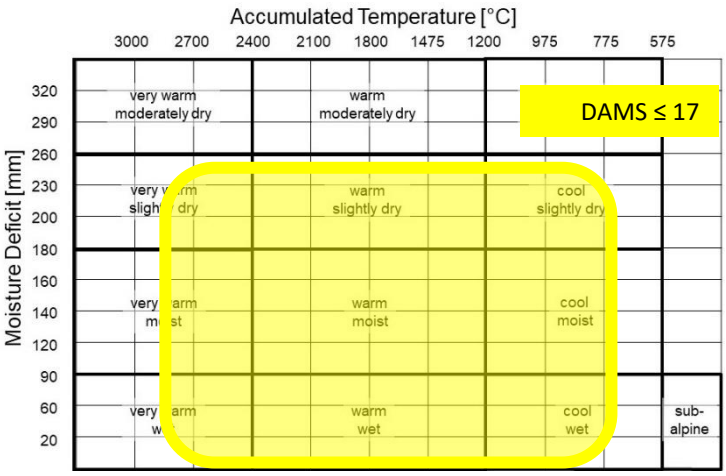
FDT 1.2.3 NS and SS

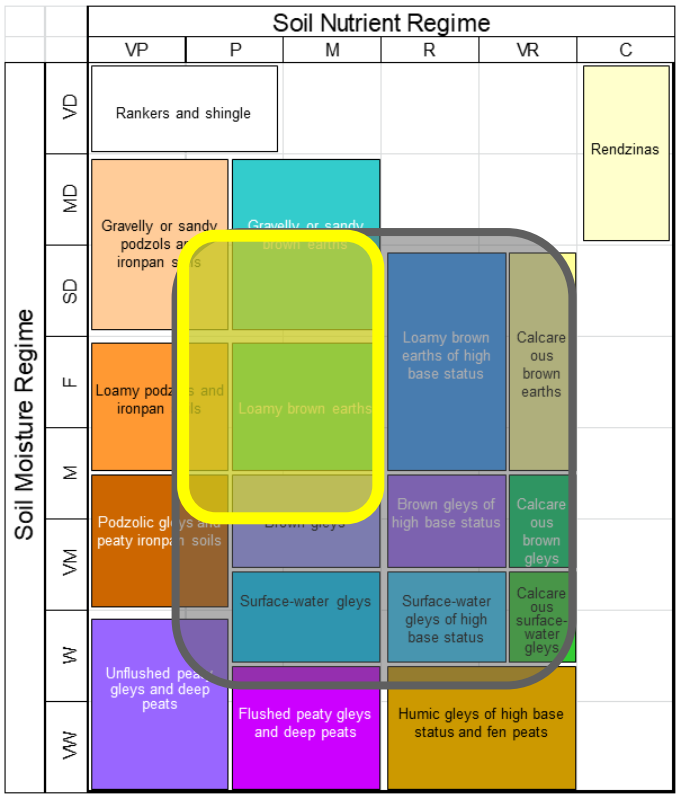


1. Structure and dynamics:
Stands of dominating NS interspersed with individual trees to small areas of SS occupying wetter parts. Horizontal structure may range from even-aged and single storied to complex. Species may be mixed intimately, in small or large groups, or in patches. Supplemented by minor species of category A.
Species distribution: NS 70 – 90% SS 10 – 20% minor species: < 10%
Stands may be managed under a wide range of options. Natural regeneration should be used wherever practical as long as the species balance is maintained; NS may have to be planted where necessary.



2. Ecological suitability:
Resembles NS-dominated natural woodland communities of central European mountain regions but allows for productive SS element on suitable microsites. Represents no NVC type but provides niches for elements of W4, W11, W15, W16 and W17. Suitable for mostly free draining, loamy soils of better fertility where NS achieves GYC 18 or more.





3. Management objectives:

Economic (NS GYC > 16):	NS – sawlogs, target DBH > 50cm in 80 – 120yrs
	SS – sawlogs, target DBH > 50cm in 60 – 100yrs
Environmental and social:	Structural and species diversity provides a wider range of habitats and improves stability. Minor species contribute to maintaining soil fertility. High landscape and amenity value due to mixed components and stand structure.

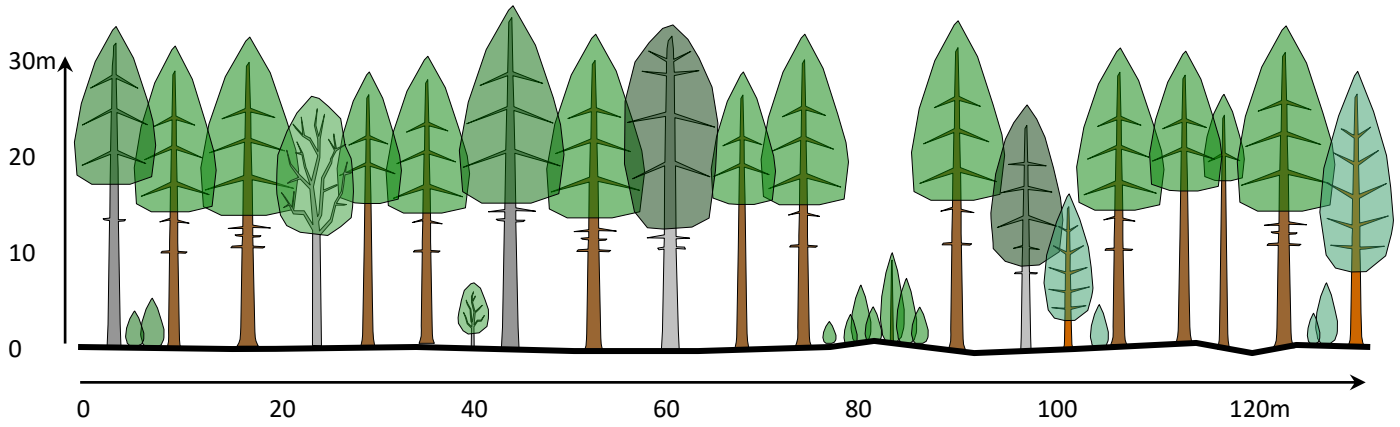
4. General management principles for the FDT

NS and SS are compatible to grow in mixture (CS = 2); the faster growth rate of SS being compensated by the greater shade tolerance of NS. The earlier seeding age of SS may pose a problem in LIMA / CCF scenarios, with profuse SS regeneration often likely to overcome NS. Early and repeated respacing of dense SS regeneration is therefore essential to secure NS on site. Management of young stands will be similar to FDT 1.2.2. Respacing and thinning must generally promote NS over SS in order to maintain the species composition. A no thinning approach is possible but will limit management options and achievable target DBH. Both species respond well to thinning throughout their life, however thinning must not be unduly delayed in order to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree stability. Due to its faster growth rate SS may be harvested slightly sooner than NS. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Infill of < 10% minor species is to be tolerated / promoted for diversity.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (predominantly NS).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, favouring NS. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method to be used (simple or complex) and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method, time with NS mast years if possible. • In shelterwood scenarios, reduce BA to 35 – 40m^2/ha initially; higher BA values will benefit regeneration of NS compared to SS. Delay reducing BA further until NS regeneration is secure in the mixture. • For complex scenarios interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.2.4 NS and shade tolerant conifers (XCST)

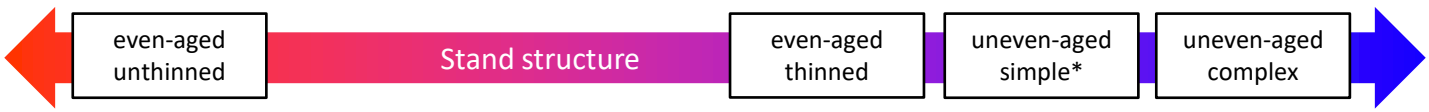


1. Structure and dynamics:

Mixed stands of NS and one or several XCST species, likely to include DF, WH, firs, WRC and others. Stands may be even-aged and single storied, or may develop into a complex structure. Mixture can be intimate, in small or large groups, or in patches. Supplemented by minor species of category A.

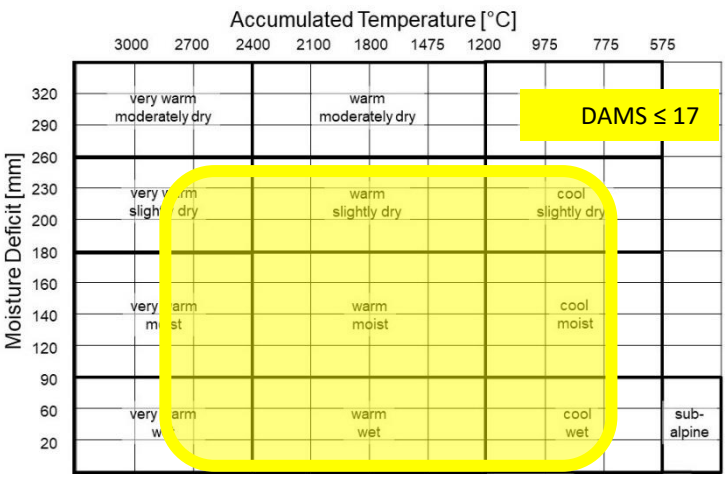
Species distribution: NS 60 – 80% XCST 20 – 40% minor species: < 10%

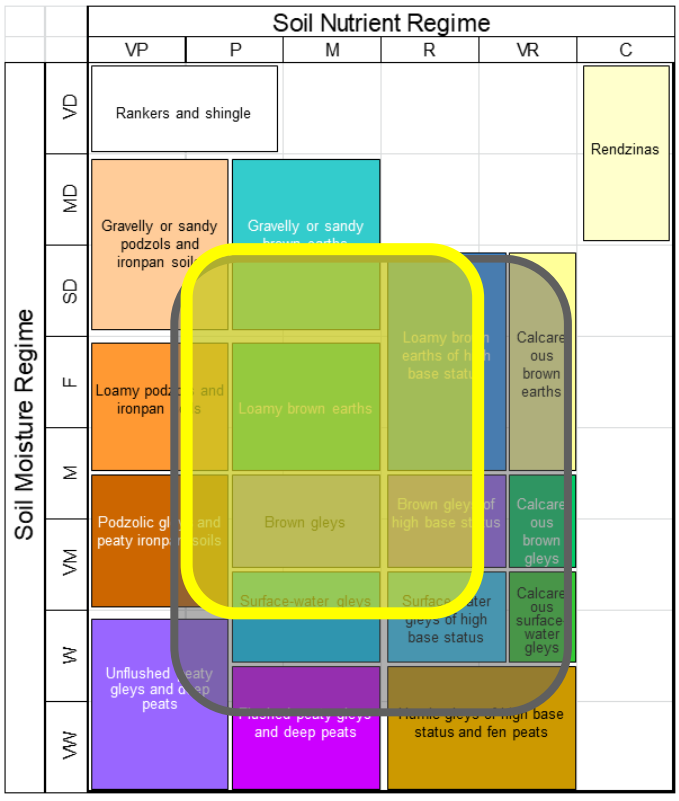
Management is likely to be by clearfelling and restocking, or by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:

Resembles NS-dominated natural woodland communities of central European mountain regions. Provides niches for elements of W4, W11, W15, W16 and W17. Suitable for freely draining, loamy soils.





3. Management objectives:

Economic: NS – sawlogs, target DBH > 50cm in 80 – 120yrs
XCST – sawlogs, target DBH > 50cm in 80 – 120yrs

Environmental and social: Increased habitat diversity, stand stability and maintenance of soil quality compared to pure stands. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation. May be an opportunity to introduce emerging species.

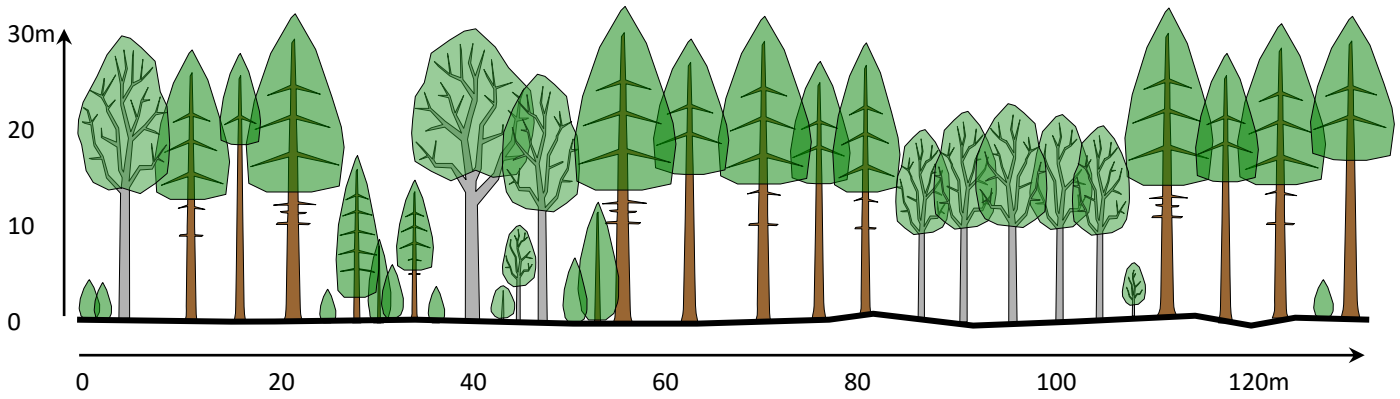
4. General management principles for the FDT

Generally these mixtures are compatible (CS = 1 or 2) as shade tolerance is similar but there may be small differences in growth rate. Also, XCST are likely to reproduce earlier and more prolifically than NS (the presence of WH could actually lead to similar problems as SS in FDT 1.2.3). Monitoring the species composition of regeneration will be key and interventions such as planting and respacing will be essential to achieving a desirable species composition. Management of young stands will be similar to FDT 1.2.2. A no thinning approach is possible but will limit management options and achievable target DBH. NS as well as XCST respond well to thinning throughout their lifetime, however thinning must not be unduly delayed in order to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration as many XCST may struggle to establish under open ground conditions. Complex CCF systems are a realistic option for this FDT.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration • XCST may be planted as beat-up or to supplement natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Steering of NS / XCST proportion in natural regeneration, promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (NS + XCST).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. • In shelterwood scenarios, reduce BA to 35m^2/ha initially and then further once regeneration has established. • For complex scenarios interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.2.5 NS and BE

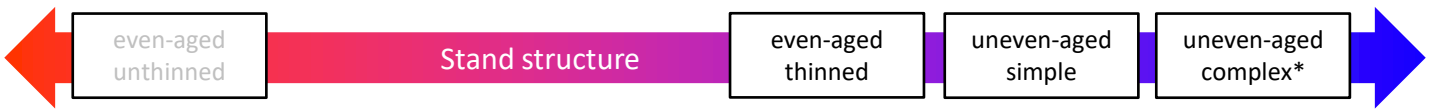


1. Structure and dynamics:

Vertically structured stands of NS with admixed BE in small groups to small areas. Supplemented by minor species of category A.

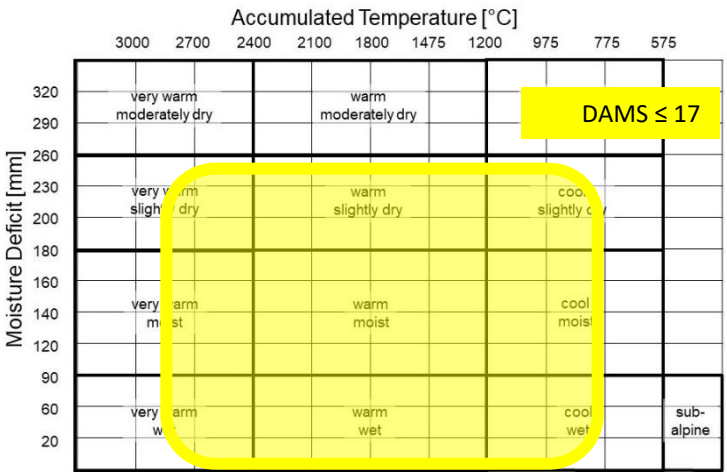
Species distribution: NS 50 – 70% BE 20 – 40% minor species: 10 – 20%

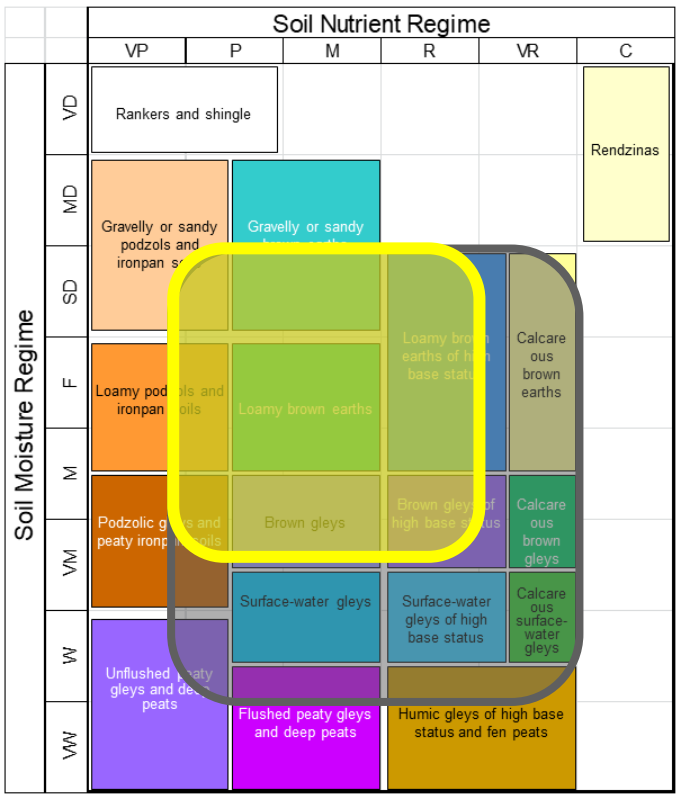
Management is likely to be by LIMA / CCF, with BE managed in groups in order to encourage stem straightness and self-pruning. Natural regeneration is to be used wherever possible and should account for the majority of all species components.



2. Ecological suitability:

Represents NS-dominated natural woodland communities of central European mountain regions. Represents no NVC type but provides niches for elements of W4, W11, W15, W16 and W17. Suitable for freely draining, loamy soils.





3. Management objectives:

Economic (GYC > 12): NS – sawlogs, target DBH > 50cm in 80 – 120yrs
BE – optional, sawlogs, target DBH > 50cm in 80 – 140yrs

Environmental and social: BE element will improve soil quality and biodiversity value compared to pure NS stands. BE is also expected to improve stand stability and productivity. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation.

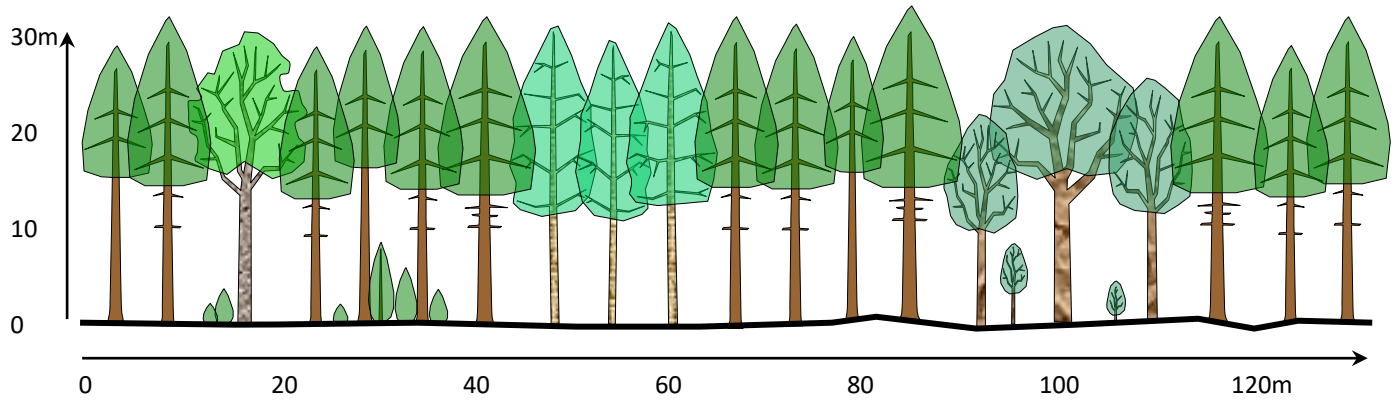
4. General management principles for the FDT

The role of BE in this FDT is for environmental, social and economic benefits alike. NS and BE are very compatible (CS = 1) to grow in mixture; the faster growth rate of NS being compensated by the higher shade tolerance of BE. However, timber quality of BE is likely to benefit from being grown in groups rather than intimate mixture. Management of young stands must aim to develop vigour and quality in BE, and individual tree stability in NS. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. Both species will respond well to thinning throughout their lifetime but in order to maintain good tree stability of NS thinning must not be unduly delayed. Thinning of NS should start at around 10 – 12m top height, generally as crown thinning. Thinning of BE should aim to produce vigorous trees of good quality, thinning in BE groups may therefore start later. LIMA / CCF methods should be the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	Intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • BE should be planted in small groups (< 0.03ha) if sawlog production is envisaged, otherwise mixed in individually or in rows.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing of NS if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing of dense BE regeneration (wolf trees). • Release 300 – 400 NS FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning in NS, removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (NS + BE).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • First selective crown thinning of BE groups when FC trees have developed a sufficiently long clean bole. • Focus on FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Assess potential for natural regeneration and consider LIMA / CCF options.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Reduce BA in shelterwood scenarios to 35m^2/ha initially and then further once regeneration has established. • For complex scenarios interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 1.2.6 NS and long-lived broadleaves (XBLL)

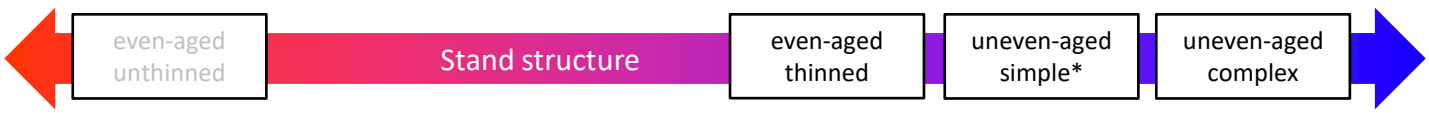


1. Structure and dynamics:

Single to multiple storeyed stands of NS interspersed with XBLL including OK, SY, AH, AR and others, mostly occurring in riparian zones and on microsites unsuitable for NS. XBLL in small or large groups, depending on light requirements and microsite conditions. Supplemented by category A minor species.

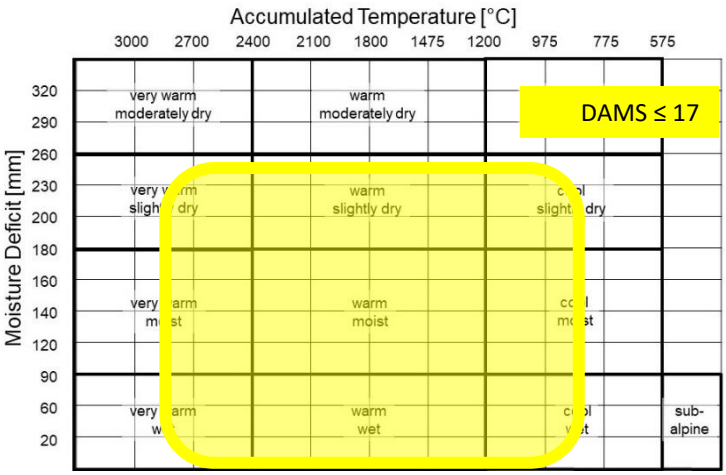
Species distribution: NS 60 – 80% XBLL 20 – 40% minor species: < 10%

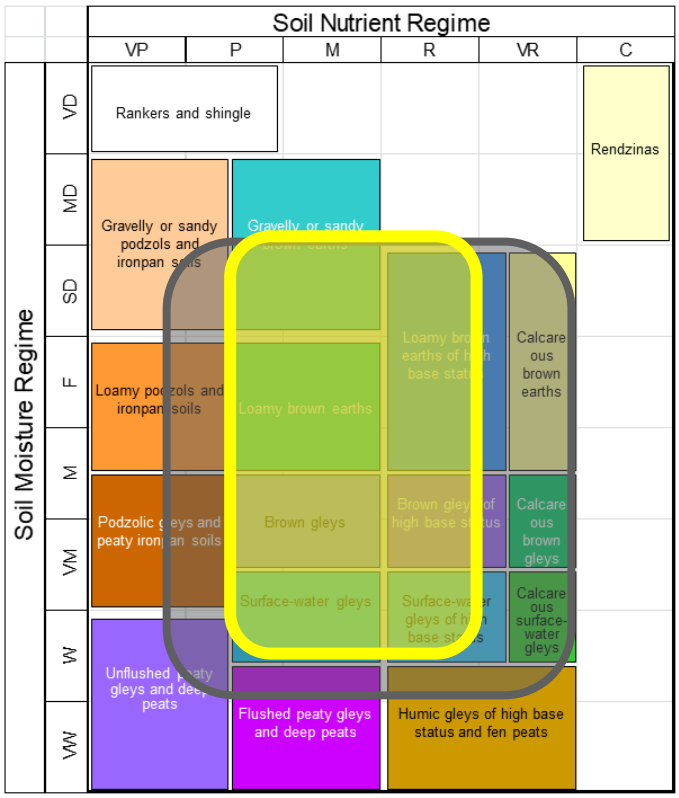
Management is likely to be by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:

Represents NS-dominated natural woodland communities of central European mountain regions. Represents no NVC type but provides niches for elements of W4, W7, W9, W11, W15, W16 and W17. Suitable for freely draining, loamy soils of medium or better fertility where NS achieves GYC 16 or more.





3. Management objectives:

Economic (GYC > 14): NS – sawlogs, target DBH > 50cm in 80 – 120yrs
XBLL – optional, sawlogs, target DBH > 50cm in 80 – 140yrs

Environmental and social: XBLL element will better maintain soil quality, increase biodiversity value, improve stand stability and add value to timber production compared to pure NS stands. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation.

FDT 1.2.6 NS and long-lived broadleaves (XBLL)

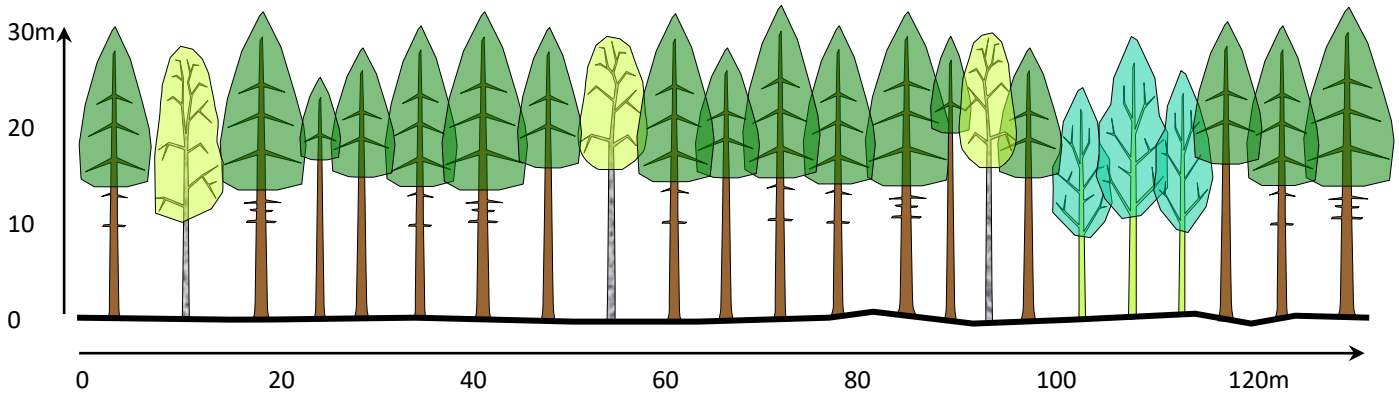
4. General management principles for the FDT

Species in this FDT are compatible (CS = 2) but timber quality in XBLL will generally benefit from spatial separation of both components. Some species such as CAR (CS = 3) may be separated from NS based on microsite conditions. Management of young stands must aim to develop vigour and quality in XBLL, and individual tree stability in NS. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. NS will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed and should start at around 10 – 12m top height, generally as crown thinning. Thinning of XBLL must aim to develop and maintain large crowns in order to produce vigorous and stable trees; thinning of XBLL in groups may start later than in NS if timber quality is a management objective. LIMA / CCF methods are the preferable option for final harvesting / restocking.

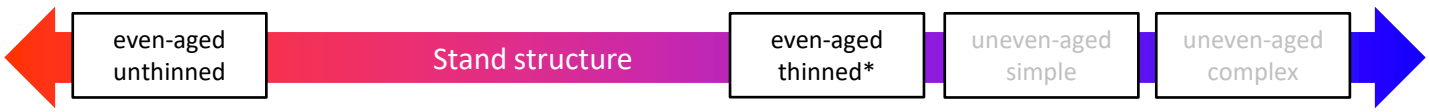
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • XBLL should be planted in robust groups (< 0.5ha) or rows depending on compatibility and envisaged production targets.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing of NS if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing of dense XBLL regeneration. • Release 300 – 400 NS FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (NS + XBLL).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between NS and XBLL and adjust thinning accordingly. • Thinning in groups of XBLL suitable for timber production should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Consider the same 3 points as shown for FDT 1.2.5.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method, time with mast years if possible. Choice of method should take into account the light demanding nature of individual XBLL species. • In shelterwood scenarios, reduce BA to 30m²/ha initially, and further once regeneration has established. • For complex scenarios, interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

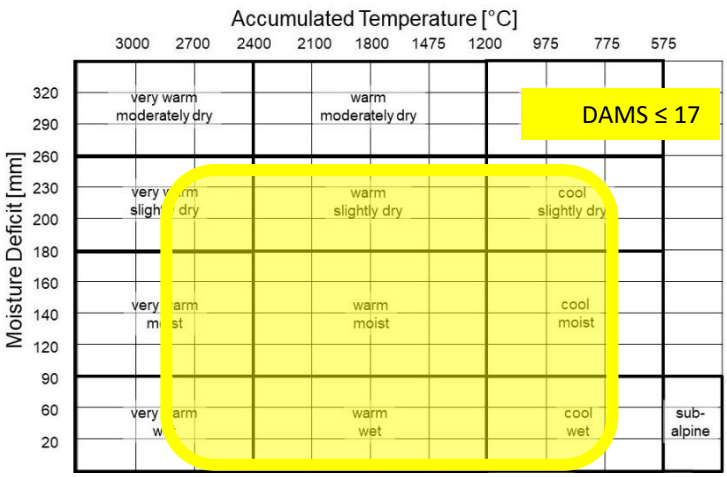
FDT 1.2.7 NS and short-lived broadleaves (XBSL)

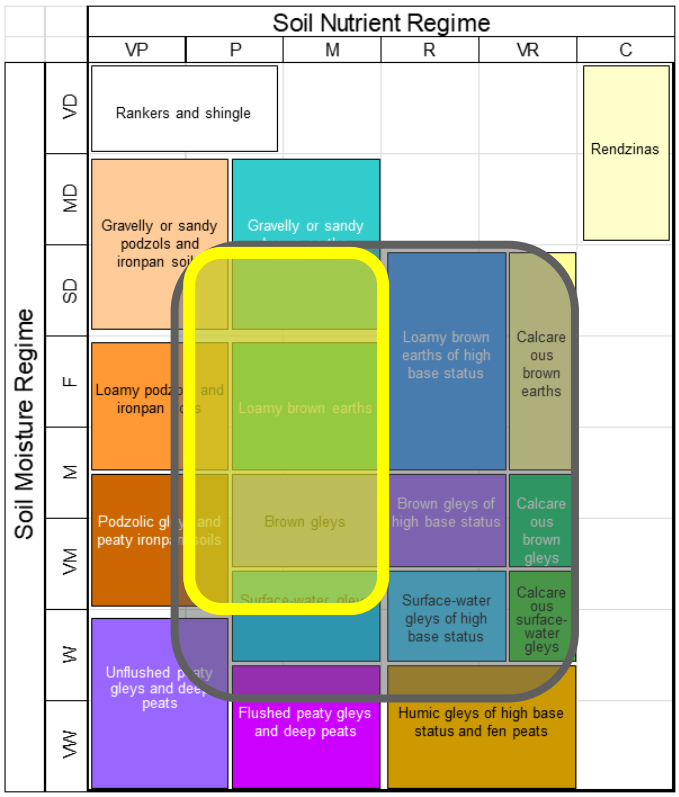


1. Structure and dynamics:
Even-aged stands of NS interspersed with XBSL. Likely to have originated from XBSL infill in NS plantation, mainly with BI, WIL, ASP, ROW. Minor species may also include any others of category A. Species may be mixed intimately, or in small to large groups.
Species distribution: NS 70 – 90% XBSL 10 – 30% minor species: < 10%
The XBSL component will often be the result of NS having partially failed at restocking. Thus, the reasons for failure need to be established in order to avoid recurrence. Transformation to another FDT may be considered, otherwise stands will largely be managed under a clearfell-and-restock regime.



2. Ecological suitability:
Represents no NVC type but provides large niches for elements of W4, W17 and W18. May be considered transition stage. Suitable for freely draining, sandy to loamy soils of medium or lower fertility where NS is sub-optimal (GYC > 10).





3. Management objectives:

Economic (GYC > 10):	NS – sawlogs, target DBH > 50cm in 80 – 120yrs XBSL – optional
Environmental and social:	XBSL elements act as soil improvers, increase habitat diversity and improve stability with regard to risk factors over pure NS stands. The mixed character of the stand is likely to be attractive and popular for amenity and recreation.

FDT 1.2.7 NS and short-lived broadleaves (XBSL)

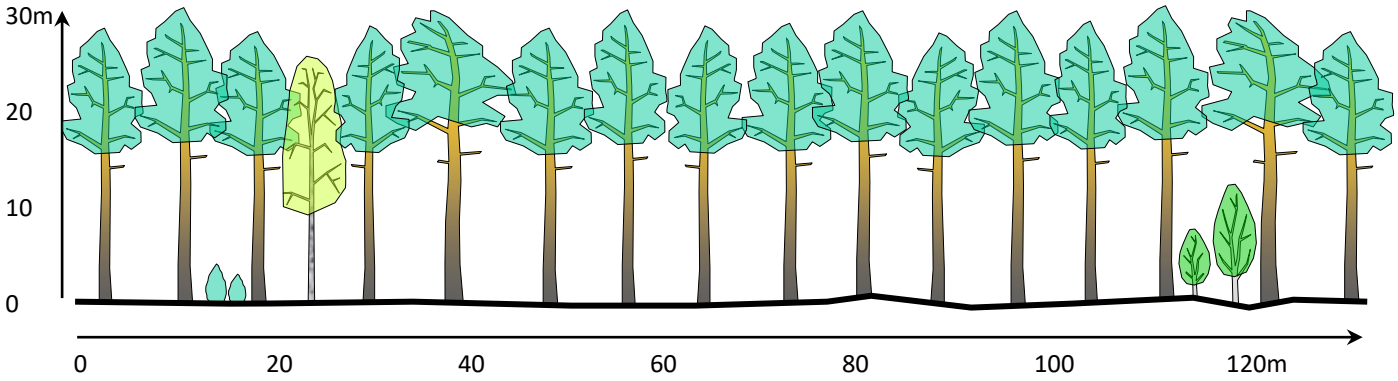
4. General management principles for the FDT

This FDT should be used where clearfell-and-restock scenarios with NS are envisaged and some species diversity is desirable. The role of XBSL may therefore be mainly for environmental and social benefits, however economic opportunities arising from biomass / timber production should be used wherever possible. The FDT may also be the result of prolific XBSL infill in NS plantations; in this case a review of the FDT may be required. Generally NS and XBSL are not compatible (CS = 3) to grow in mixture; however, most XBSL will be able to keep up with NS growth rate and could be maintained in groups with frequent thinning. Management of young stands should aim to achieve canopy cover and maintain even growth of all stand components. Rare stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability, which is essential for retaining thinning options. A no thinning approach is possible but will limit management options and achievable target DBH. NS will respond well to thinning throughout its lifetime but the thinning of XBSL must focus on early interventions if sawlog dimensions are to be achieved. Thinning should start at around 10 – 12m top height, generally as crown thinning. Thinning should aim to maintain species composition and canopy cover.

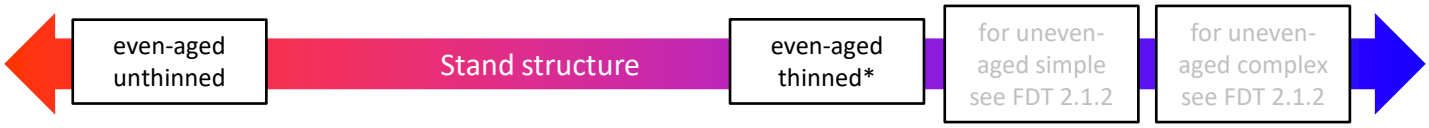
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha, XBSL often from natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (NS + XBSL).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor crown length and h/d ratio in NS (stability indicators), species composition, height growth and canopy cover in NS and XBSL (competition indicators), and thin accordingly. • Apply crown thinning as long as necessary for benefits of FC trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when FC trees approach target DBH. • NS is unlikely to regenerate naturally, however, opportunities to take advantage of natural regeneration may arise on longer rotations and should be used where practical.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

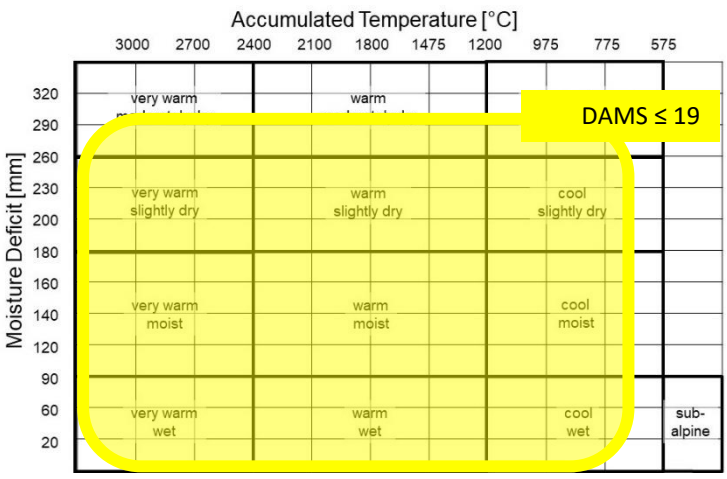
FDT 2.1.1 SP

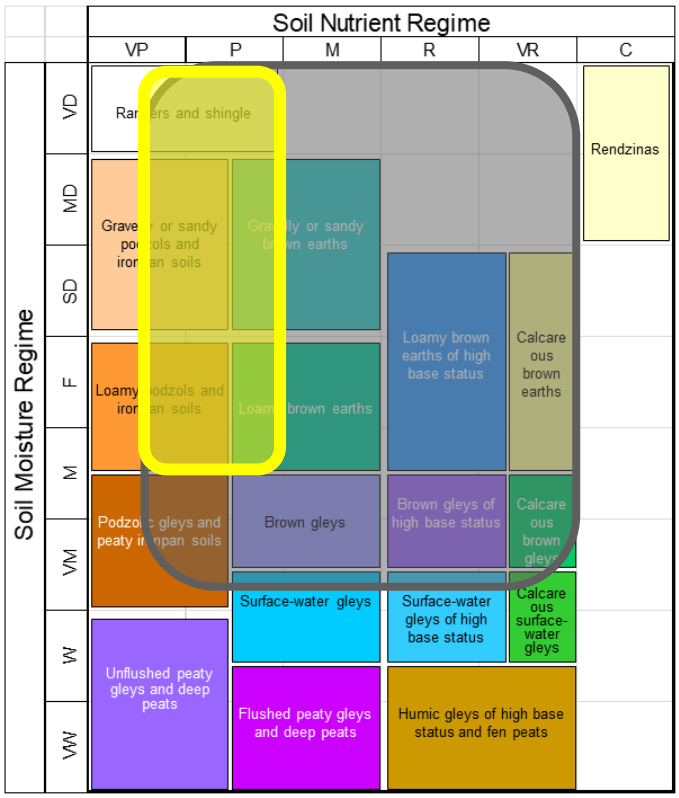


1. Structure and dynamics:
Single-storeyed SP stand with category B minor species (mainly SBI and ROW).
Species distribution: SP 80 – 100% minor species: < 20%
Stands are likely to be managed under clearfell-and-restock regime, ideally on rotations of ≥ 80 yrs.
Natural regeneration of SP should be encouraged and used wherever possible; minor species should regenerate naturally.



2. Ecological suitability:
Represents the NVC type W18 with elements of W17 or W16 in the upland and lowland climate zones. This FDT belongs on nutrient poor sandy soils with low to intermediate water supply where SP produces good timber quality without reaching its maximum productivity (GYC < 12), and is likely to regenerate.





3. Management objectives:

Economic (GYC < 12):	SP – sawlogs, target DBH > 40cm in 100 – 140yrs
Environmental and social:	Woodland of natural appearance, providing habitats for light demanding species. Presence of veteran trees and deadwood. With increasing age the relatively open structure will contribute to the conservation and amenity value of these forests.

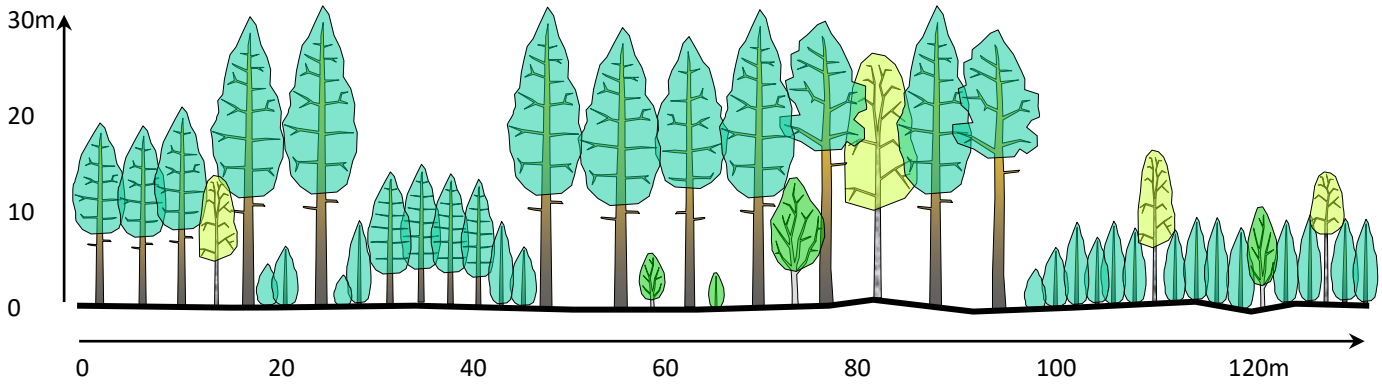
4. General management principles for the FDT

This FDT is for even-aged stands of SP growing on low fertility sites where SP can deliver management objectives. Stands should be established at higher density than 2500 trees/ha if timber production is an important objective, to provide scope for stem selection during the rotation. Management of young stands should aim to achieve timber quality and maintain even and rapid growth. Developing good tree stability is also important if the stand is to be thinned. A no thinning approach is possible but will limit management options and achievable target DBH. Timber quality in SP is more variable than in other conifers, and quality selection during respacing and thinning therefore more important. The growth response of SP to thinning interventions peaks early in life and diminishes rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Thinning should start at 10 – 14m top height, generally as crown thinning. Thinning at later stages should aim to maintain an even canopy cover and steady growth. Clearfell-and-restock is the main management scenario envisaged. Opportunities for natural regeneration should be used wherever possible as high initial stocking densities offer an opportunity to improve timber quality. LIMA / CCF methods such as the seed tree or strip systems should therefore be considered where natural regeneration is abundant.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 200 – 300 FC trees/ha (optional).
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP becomes less responsive to thinning. • Plan for final harvesting when dominant trees / FC trees reach target DBH. • Opportunities to take advantage of natural regeneration may arise on suitable sites and longer rotations, and should be used where practical.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • On sites conducive to natural regeneration, seed tree and strip systems combined with ground scarification provide the best LIMA / CCF options and may offer an opportunity to transform the stand to FDT 2.1.2. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.1.2 SP

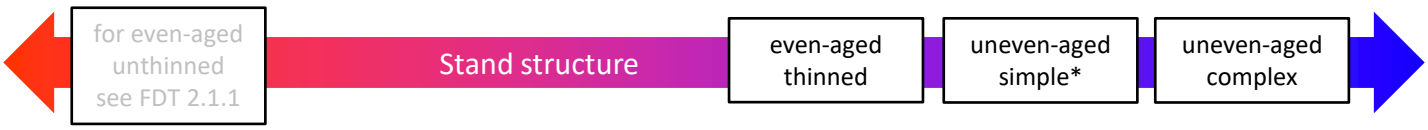


1. Structure and dynamics:

Vertically structured SP dominated stands of two or more storeys and multiple-aged. Supplemented by category B minor species (predominantly SBI and ROW).

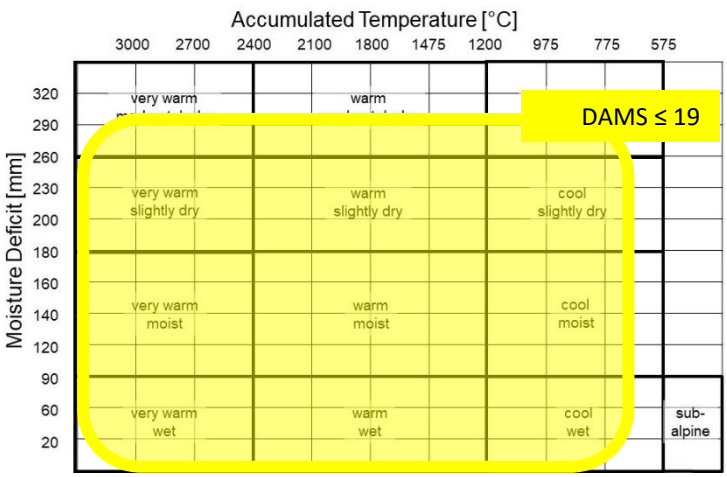
Species distribution: SP 70 – 90% minor species: 10 – 30%

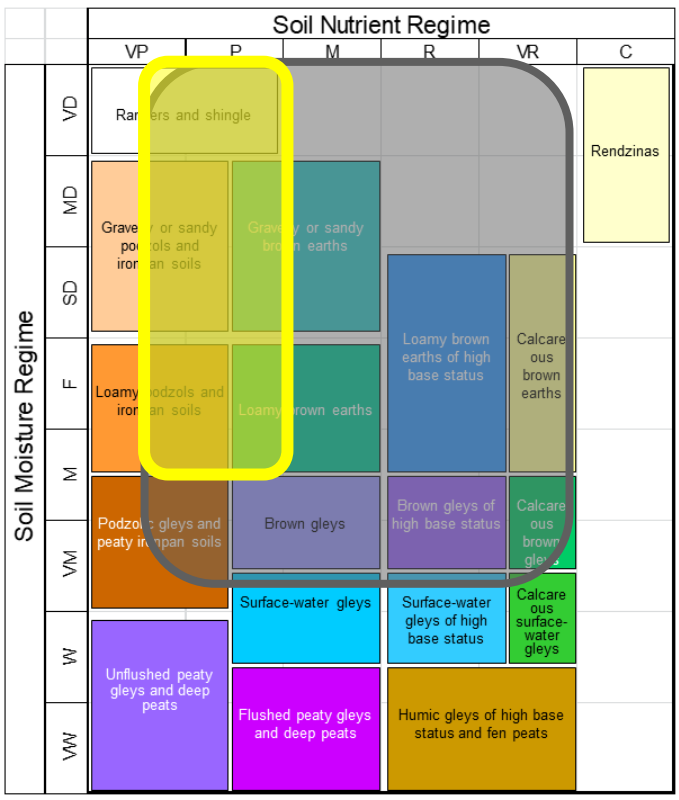
Stands will be managed by LIMA / CCF. SP regeneration may be by restocking but preferably by natural regeneration; minor species should regenerate naturally.



2. Ecological suitability:

Represents the NVC type W18 with elements of W17 or W16 in the upland and lowland climate zones, differs from FDT 2.1.1 by its more diverse structure. Appropriate on nutrient poor sandy soils with low to intermediate water supply where SP produces good timber quality without reaching its maximum productivity (GYC < 12), and is likely to regenerate.





3. Management objectives:

Economic:	SP – sawlogs, target DBH > 40cm in 100 – 140yrs
Environmental and social:	Minor species increase diversity and improve soil conditions. Visually attractive with a range of tree sizes and some autumn colour. Provides good recreation environment. Presence of veteran trees and deadwood. The use of CCF / LIMA management will enhance environmental and social benefits.

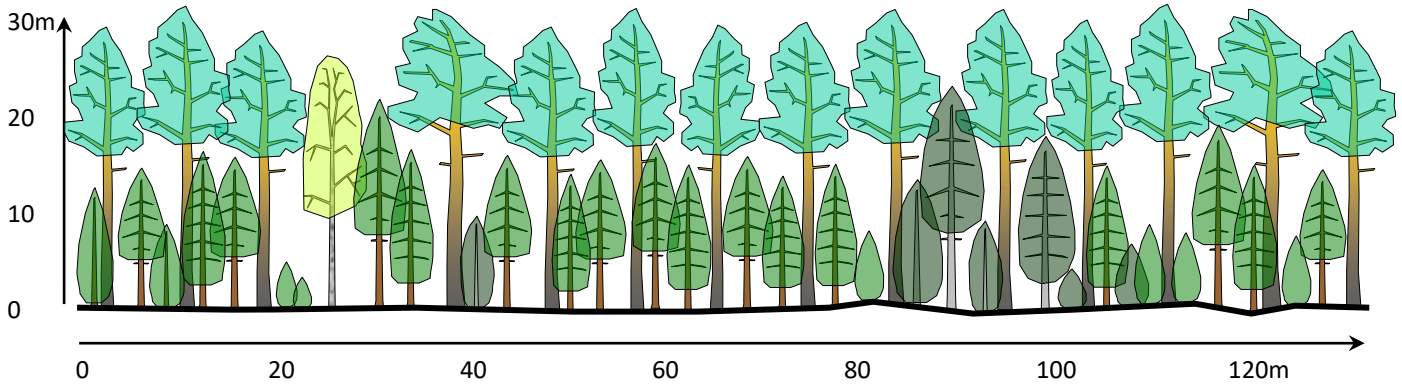
4. General management principles for the FDT

This FDT is for productive SP stands of high timber quality and on low fertility sites where structural diversity is desirable and SP shows good potential to regenerate naturally. Stands should be established at higher density than 2500 trees/ha to provide scope for stem selection during the rotation. Management of young stands should aim to achieve tree stability, timber quality, and maintain even and rapid growth. Timber quality in SP is more variable than in other conifers, and quality selection during respacing and thinning therefore more important. Wolf trees and other undesirable stems should be eliminated as early as possible and the best individuals be promoted as FC trees. The growth response of SP to thinning interventions peaks early in life and diminishes rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Thinning should start at 10 – 14m top height, generally as crown thinning. Thinning at later stages should aim to maintain tree stability and steady growth. LIMA / CCF methods such as strip, seed tree or shelterwood systems with quick canopy removal are most suitable to achieve the desired vertical stand structure.

5. Timeline

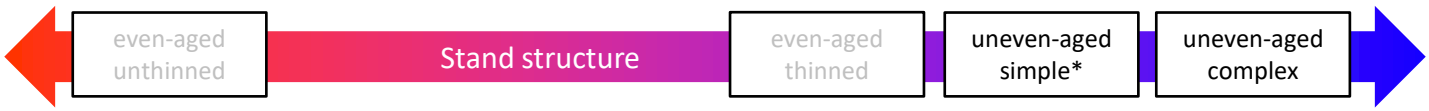
stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 300 – 400 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha, consider pruning.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP becomes less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Ground scarification to expose the mineral topsoil will generally improve chances for natural regeneration. • In shelterwood scenarios, reduce BA to 25m^2/ha initially, and further once regeneration has established. Design strip systems with regard to prevailing wind direction and climatic requirements of SP regeneration; keep strip width < 50m. In seed tree scenarios, consider retaining 20 – 50 seed trees/ha for a second rotation. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.1.3 SP and shade tolerant conifers (XCST)



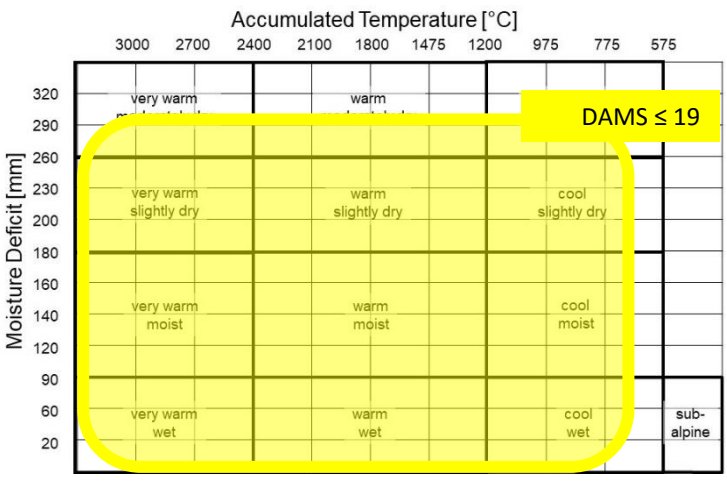
1. Structure and dynamics:

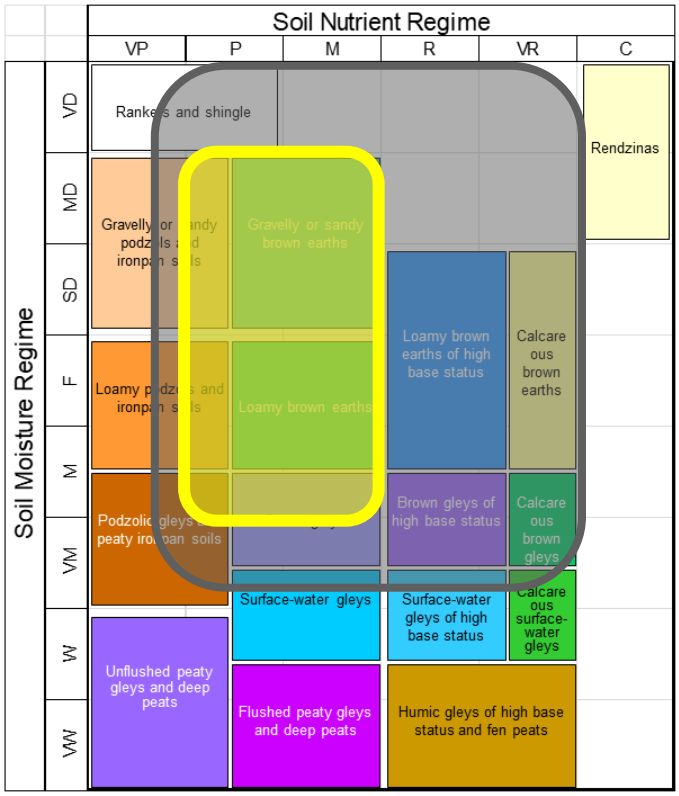
Stands with an SP overstorey and XCST understorey, most likely of species such as NS, SS, WH, WRC and firs; plus minor species of category B. The horizontal mixture type may range from intimate to patches.
Species distribution: SP 60 – 80% XCST 20 – 40% minor species: < 10%
This FDT may be managed under LIMA / CCF scenarios where the XCST understorey is removed just before SP final harvesting and (preferably natural) regeneration. Alternatively it can be considered as a transition type towards the XCST component.



2. Ecological suitability:

Contains elements of NVC type W18 and provides niches for components of W17, W16 and W15. Appropriate on soils with sandy to loamy texture and poor to medium fertility where SP achieves GYC > 8 but may struggle to regenerate.





3. Management objectives:

Economic:	SP – sawlogs, target DBH > 50cm in 100 – 140yrs XCST – sawlogs, target DBH > 40cm in 60 – 100yrs
Environmental and social:	The XCST element provides increased stand diversity and a wider range of habitats. It can also control aggressive ground vegetation which often establishes under SP canopy on medium fertility sites. The range of tree sizes and diverse stand structure is visually attractive and provides a good environment for recreation and amenity. Option for introducing emerging species.

FDT 2.1.3 SP and shade tolerant conifers (XCST)

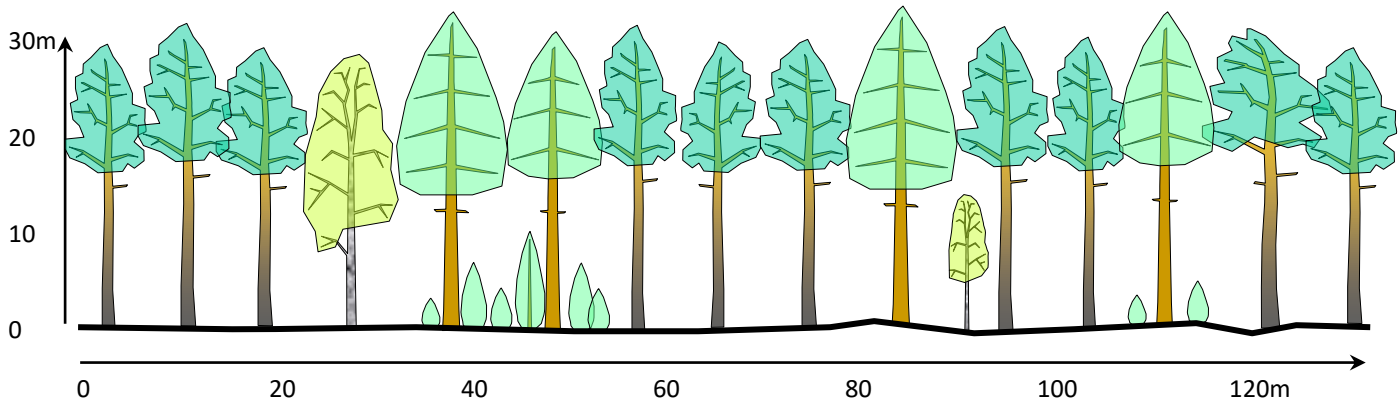
4. General management principles for the FDT

This FDT is designed for productive SP stands on better sites than FDT 2.1.2 where SP is less likely to regenerate naturally. The role of XCST is to add productivity and structural diversity whilst controlling ground vegetation. The XCST component will be established by natural regeneration or underplanting after the early thinning phase in SP, leading to a distinct two-storey stand structure. Species compatibility is therefore irrelevant but careful timing of XCST establishment is important to prevent the understorey from growing into the SP canopy too soon. SP should be established and managed similar to FDT 2.1.2. The XCST understorey will eventually catch up with SP in height growth; at this point the FDT needs to be reviewed. Further management will depend on the decision of continuing with a SP dominated FDT or switching to XCST; in either case LIMA / CCF methods should be the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 300 – 400 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha. • Pruning of some FC trees may be considered.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP becomes less responsive to thinning. • Establish XCST, either by natural regeneration or underplanting. Stocking density may be slightly lower than in open ground scenarios. • Respace and thin XCST according to species specific guidance. • Review FDT and plan for final harvesting when XCST start growing into SP canopy and SP FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.1.4 SP and light demanding conifers (XCLD)

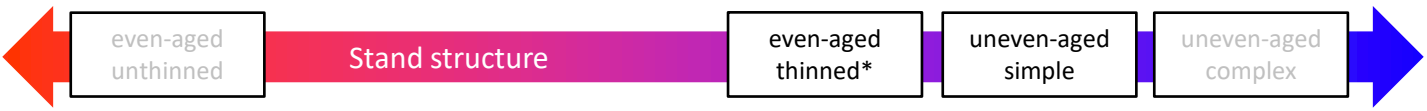


1. Structure and dynamics:

Single-storied SP stand with a component of XCLD (larches or pines) and category B minor species (mainly BI and ROW). Mixture can be intimate, in small or large groups, or in patches.

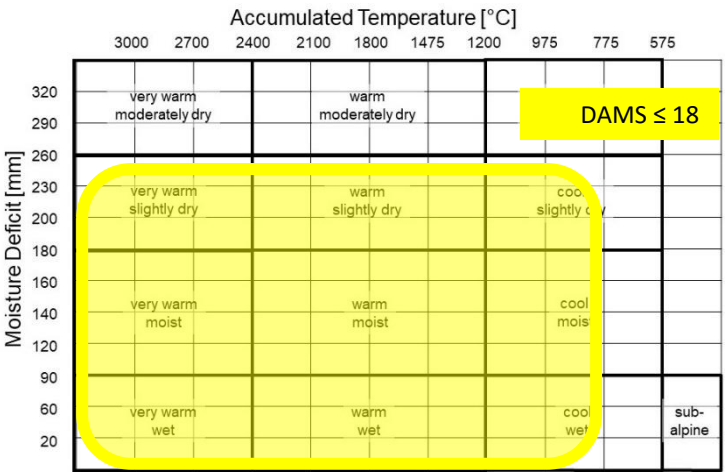
Species distribution: SP 60 – 90% XCLD 10 – 40% minor species: < 10%

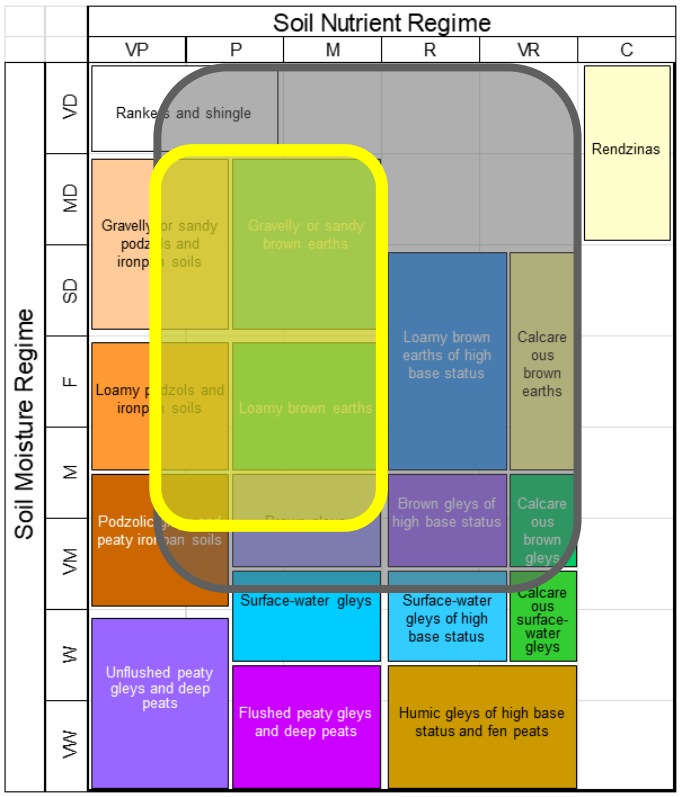
Management may be by clearfelling and restocking, or by LIMA / CCF methods using natural regeneration as far as possible, but must take account of the light demanding nature of the species.



2. Ecological suitability:

Contains elements of NVC type W18 and provides niches for components of W17, W16 and W15. Appropriate on soils with sandy to loamy texture and poor to medium fertility where SP achieves GYC > 8. A good option where additional species diversity would be desirable.





3. Management objectives:

Economic:	SP – sawlogs, target DBH > 50cm in 100 – 140yrs XCLD – sawlogs, target DBH > 50cm in 60 – 120yrs
Environmental and social:	The XCLD component provides increased stand diversity and a wider range of habitats. Stands will be visually attractive due to the mix of species and autumn colours, providing a good environment for recreation and amenity.

FDT 2.1.4 SP and light demanding conifers (XCLD)

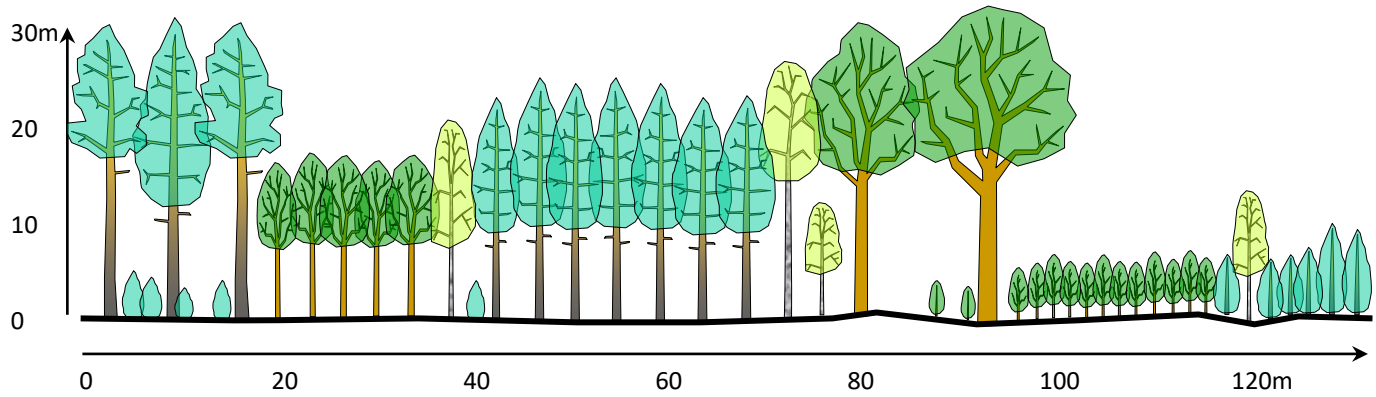
4. General management principles for the FDT

This FDT is for productive stands on better sites than FDT 2.1.2 where SP is less likely to regenerate naturally and has been established in mixture with XCLD for added productivity. SP is compatible to grow in mixtures with other pines (CS = 1) and larches (CS = 2) although the larger final crown diameter of XCLD species such as CP and larches should be considered. SP and XCLD follow a similar pattern with growth responding strongly to thinning interventions early in life and diminishing rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. SP should be established and managed similar to FDT 2.1.2; for XCLD refer to species specific guidance. Despite the general similarity in growth pattern between SP and XCLD regular monitoring is essential for taking corrective action in time should one species outgrow and dominate others. Clearfell-and-restock as well as simple LIMA / CCF methods such as strip and seed tree systems provide options for final harvesting / restocking. Natural regeneration of SP may be difficult to achieve; supplementary planting is therefore likely to be required.

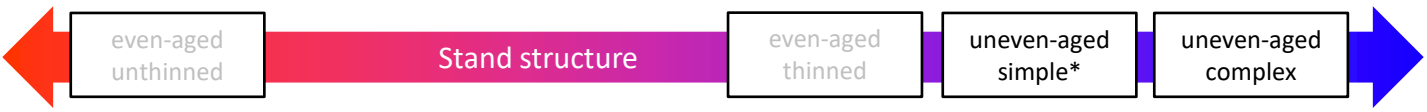
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• SP: Planting of 3000 – 8000 trees/ha or natural regeneration. • XCLD: Planting of 2000 – 4000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates in SP). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 300 – 400 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SP + XCLD). • Pruning of some FC trees may be considered.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees; maintain species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP / XCLD become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Consider LIMA / CCF methods and assess potential for natural regeneration; improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • In shelterwood scenarios, reduce BA to 25m^2/ha initially, and further once regeneration has established. • Design strip systems with regard to prevailing wind direction and climatic requirements of SP / XCLD regeneration; keep strip width < 50m. • In seed tree scenarios, retain 20 – 50 seed trees/ha for a second rotation. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

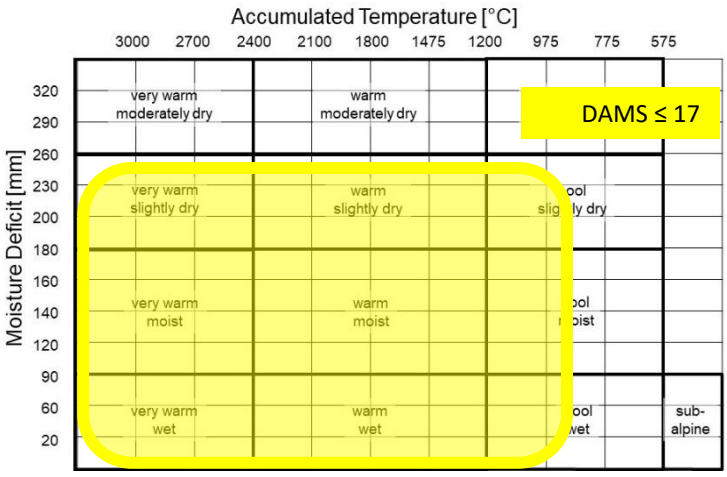
FDT 2.1.5 SP and SOK

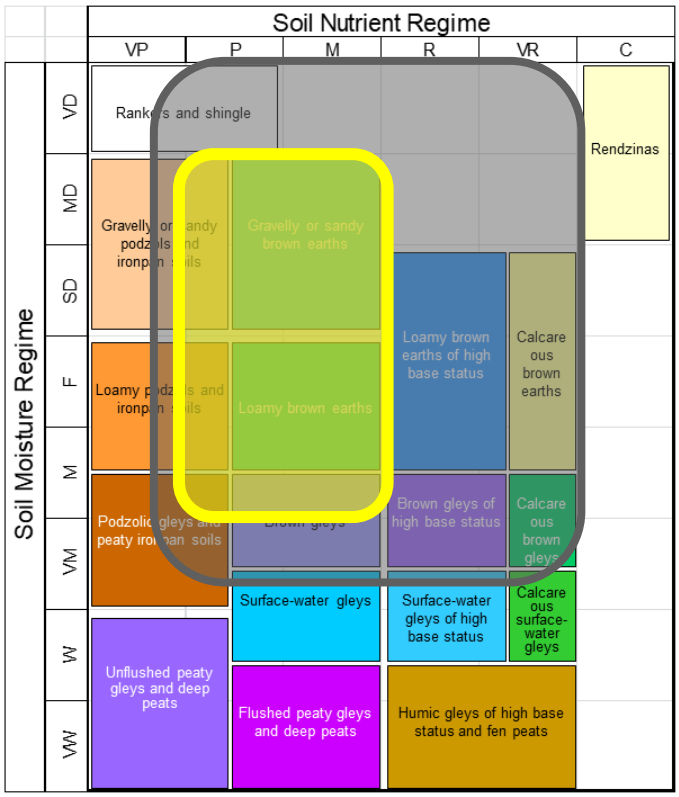


1. Structure and dynamics:
Mosaic of single-storeyed large groups or patches of SP and SOK of variable age, with individual trees or small groups of category B minor species, particularly BI.
Species distribution: SP 50 – 70% SOK: 20 – 40% minor species: 10 – 20%
SP and SOK will be managed using LIMA with single species cohorts on different rotations. SP and minor species should propagate via natural regeneration, SOK may be planted if regeneration is insufficient.



2. Ecological suitability:
Represents the overlap between NVC types W18 and W17 or W16 in the upland and lowland climate zone. This FDT belongs on nutrient poor sandy soils with low to intermediate water supply where SP performs well (GYC > 6) but SOK is also a viable option. Similar to FDT 5.2.2 (SOK and SP) but with inversed species proportions.





3. Management objectives:

Economic:	SP – sawlogs, target DBH > 40cm in 80 – 120yrs SOK – sawlogs, target DBH > 50cm in 120 – 160yrs
Environmental and social:	Woodland of natural appearance, providing habitats for light demanding species. Presence of veteran trees and deadwood. Stands will be visually attractive with a mix of species and autumn colour, providing a good environment for recreation and amenity.

FDT 2.1.5 SP and SOK

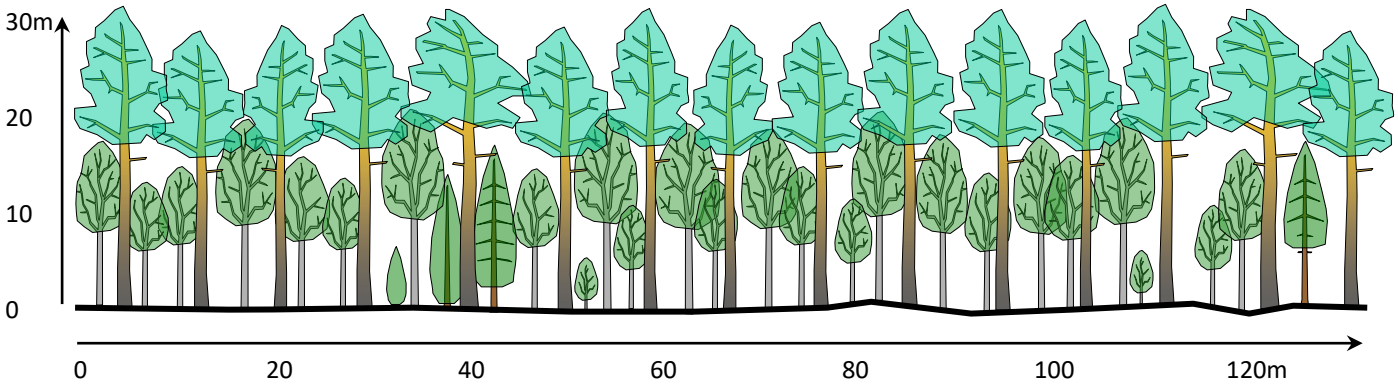
4. General management principles for the FDT

This FDT aims to create a small scale mosaic of more or less even-aged cohorts of SP and SOK on sites which are suitable for both species. SP and SOK are very compatible (CS = 1) to grow in mixtures but timber quality in SOK will generally benefit from aggregation in robust groups. Timber quality is variable in both species; requiring relatively high initial stocking density and careful quality selection during respacing and thinning. Dominant trees of poor quality need to be eliminated by selective respacing, desirable FC trees promoted by thinning. The growth response of SP to thinning interventions peaks early in life and diminishes rapidly thereafter, that of SOK declines more slowly. Thinning in SP should start at around 10 – 14m top height and focus on pole and small timber stage whilst thinning in SOK may start slightly later, usually once a clean bole of > 6m has been achieved through self-pruning. For both species crown thinning should be applied throughout. Thinning at later stages must aim to maintain tree stability and steady growth. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

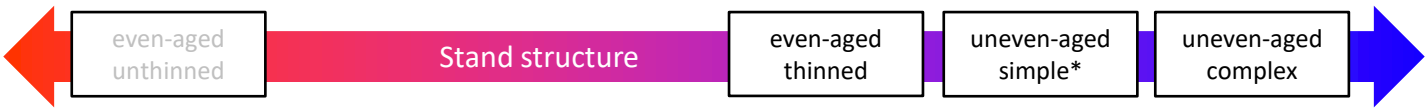
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration. Whilst individual SP may be embedded in a surrounding matrix of SOK, SOK should be established at least in robust clusters of > 25 trees.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 300 – 400 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning in SP, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (SP + SOK). • Pruning of some SP FC trees may be considered, SOK should self-prune.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between SP and SOK and adjust thinning accordingly. • Thinning in groups of SOK should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees; maintain species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP / SOK become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Follow species specific guidance for SP / SOK dominated components. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

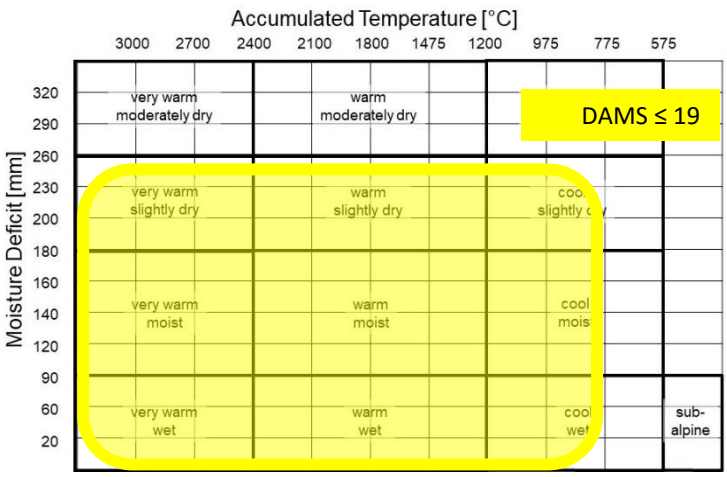
FDT 2.1.6 SP and BE

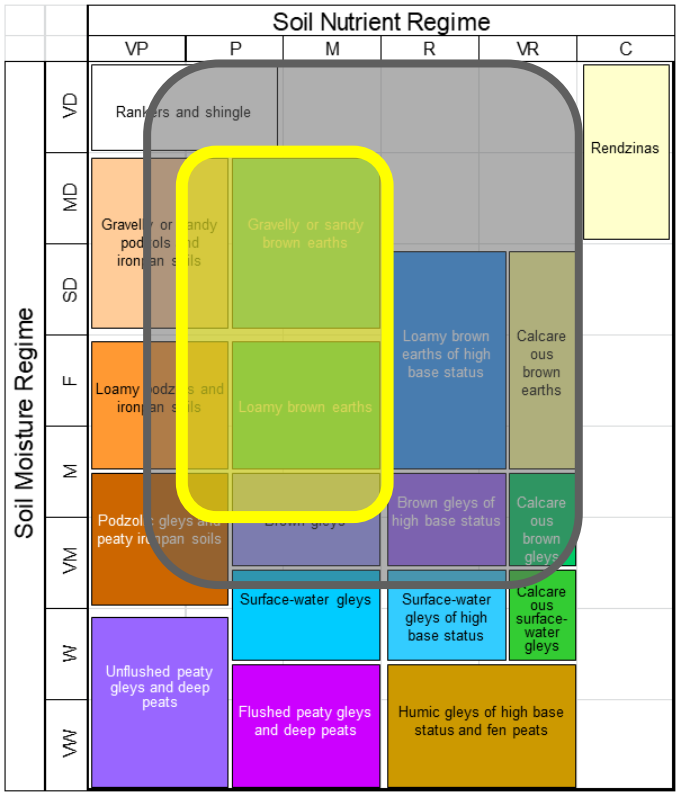


1. Structure and dynamics:
Two-storeyed stand of SP overstorey and BE understorey, with minor species of category B. The horizontal structure may range from intimately mixed to patches.
Species distribution: SP 60 – 80% BE: 20 – 40% minor species: < 10%
Likely to originate from SP underplanted with BE. This concept could be repeated as clearfell-and-restock scenario but alternatively both species may be managed under LIMA / CCF leading to a complex structure.
Natural regeneration should be used wherever possible although in most cases SP will have to be planted.



2. Ecological suitability:
Represents the overlap between NVC types W18 and W15 in the upland and lowland climate zones. This FDT should be considered on soils with sandy loam texture and poor to medium nutrient supply where SP performs well (GYC > 8) but may struggle to regenerate.





3. Management objectives:
Economic (SP GYC > 8): SP – sawlogs, target DBH > 50cm in 100 – 140yrs
BE – optional, sawlogs, target DBH > 50cm in 60 – 120yrs
Environmental and social: Woodland of natural appearance, presence of veteran trees and deadwood. BE component acts as soil improver, controls ground vegetation and thus facilitates natural regeneration of SP, also adds diversity and attractive spring and autumn aspect, thus improving the recreation and amenity value.

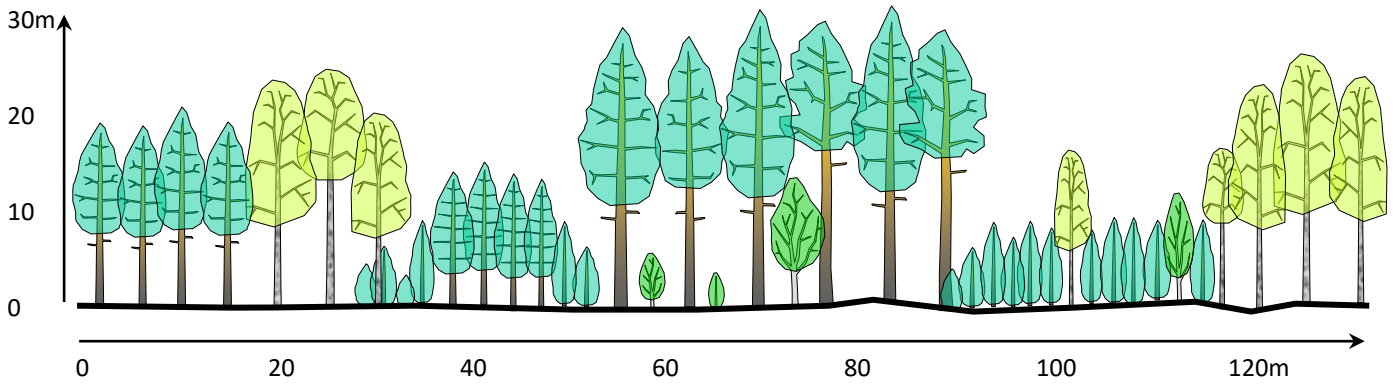
4. General management principles for the FDT

This FDT is designed for productive SP stands on better sites than FDT 2.1.2 where SP is less likely to regenerate naturally. The role of BE is to add productivity and structural diversity whilst controlling ground vegetation. SP should be established and managed similar to FDT 2.1.2. BE will be established after the early thinning phase in SP, most likely by underplanting, leading to a distinct two-storey stand structure. Species compatibility is therefore irrelevant but careful timing of BE establishment is important to prevent the understorey from growing into the SP canopy too soon. The BE understorey will eventually catch up with SP in height growth; at this point the FDT needs to be reviewed. Further management will depend on the decision of continuing with a SP dominated FDT or switching to BE; in either case LIMA / CCF methods should be the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Negative selective respacing (removal of wolf tree candidates). • Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 300 – 400 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha. • Pruning of some FC trees may be considered.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP becomes less responsive to thinning. • Establish BE, by natural regeneration or underplanting. Stocking density may be slightly lower than in open ground scenarios. • Respace and thin BE according to guidance in FDT 6.1.1 / 6.1.2. • Review FDT and plan for final harvesting when BE start growing into SP canopy and SP FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.1.7 SP and BI

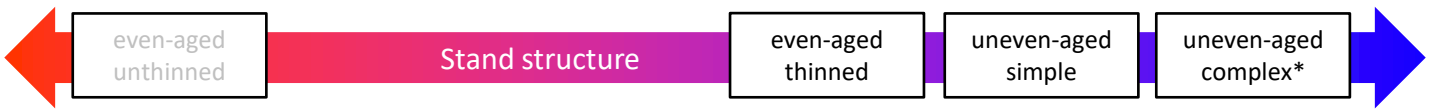


1. Structure and dynamics:

Mosaic of single-storeyed small groups to small areas of SP and BI of variable age, with individual trees or small groups of category B minor species.

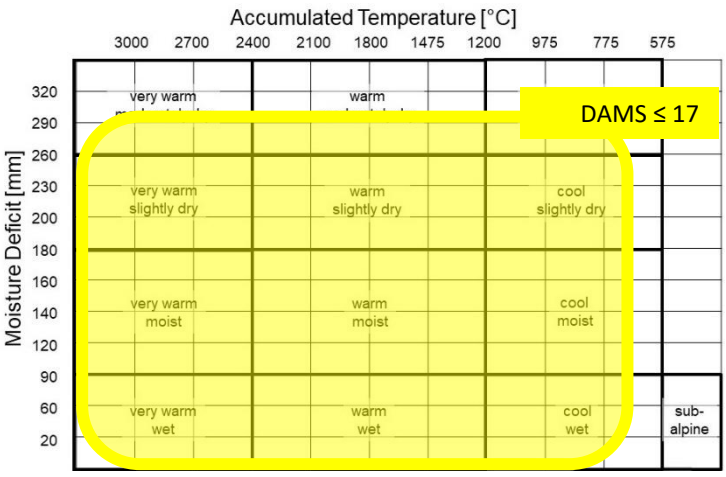
Species distribution: SP 60 – 90% BI: 10 – 40% minor species: < 10%

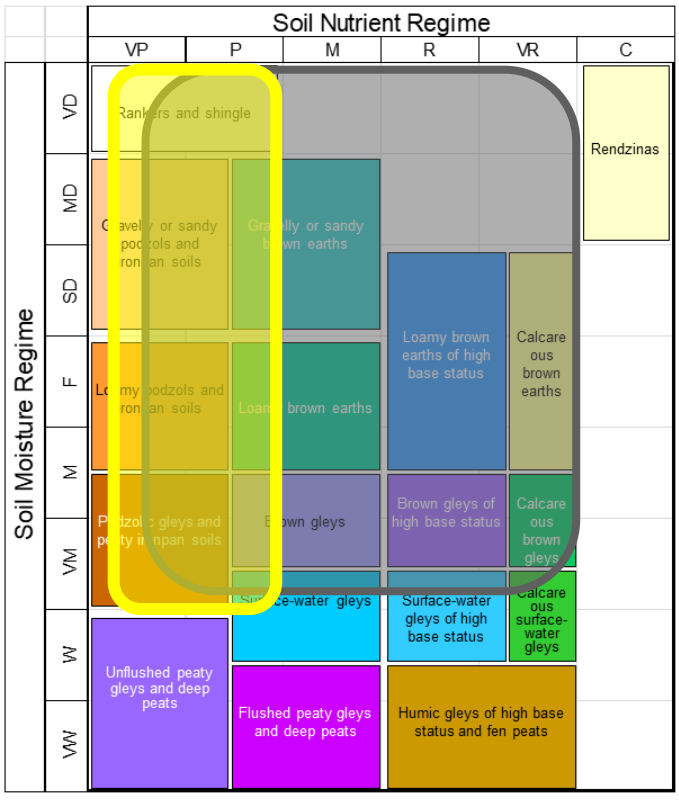
Stands will likely have developed from incomplete SP restocking with BI infill. Different rotation lengths for SP and BI is likely to diversify the stand structure further. BI and minor species will propagate via natural regeneration, SP may need to be planted if regeneration is insufficient.



2. Ecological suitability:

Represents NVC type W18 with strong presence of BI and niches for elements of W4, W17, W16 and W15. This FDT is suitable for the poorest soils where SP GYC is below 12 and BI is abundant. SBI will be more common on freely draining soils but is likely to be replaced by DBI on wetter sites.





3. Management objectives:

Economic:	SP – sawlogs, target DBH > 40cm in 100 – 140yrs BI – optional, sawlogs / pulp / chip
Environmental and social:	Open woodland of natural appearance, providing habitats for light demanding species. Presence of veteran trees and deadwood, attractive spring and autumn aspect. BI adds diversity and acts as soil improver.

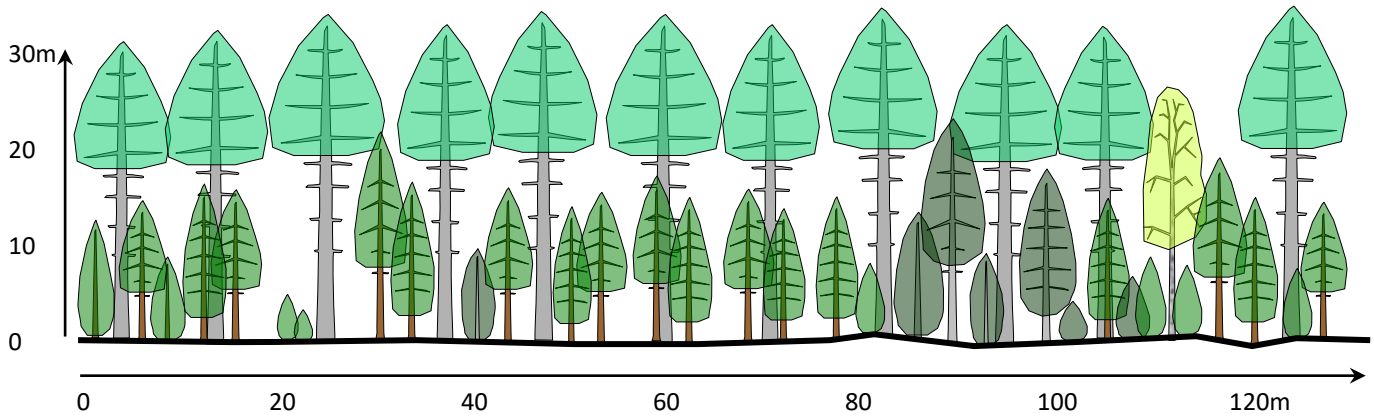
4. General management principles for the FDT

This FDT is for productive SP stands of high timber quality and on low fertility sites where higher structural and species diversity is desirable and SP shows good potential to regenerate naturally. The role of BI in this FDT is mainly for environmental and social benefits, however economic opportunities arising from biomass / timber production should be used wherever possible. As pioneer species SP and BI are quite compatible (CS = 2) to grow in mixtures, with growth rates peaking early in life and diminishing rapidly thereafter. SP management according to FDT 2.1.2. If BI is to be grown to sawlog dimensions respacing and thinning must ensure that the relative length of the live crown never drops below 60% of tree height. As a general rule, SBI should be preferred over DBI, and seed grown trees over coppice in tree selection. Thinning should start at around 10 – 14m top height, generally as crown thinning, and focus on pole and small timber stage. Thinning at later stages must aim to maintain tree stability and steady growth. BI will likely be managed on a shorter rotation than SP; LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• SP: Planting of 3000 – 8000 trees/ha or natural regeneration. • BI: Planting of 2000 – 3000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • SP: Negative selective respacing (removal of wolf tree candidates). • SP: Respacing if N > 8000 trees/ha (or lower if tree stability is a concern) at 1 – 2m tree height. • BI: Systematic respacing to about 2000 trees/ha at 2 – 4m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective (SP) / systematic (BI) respacing and careful promotion of 400 – 600 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 200 – 300 FC trees/ha (SP + BI). • Pruning of some FC trees may be considered.
Pole to small timber stage	14 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between SP and BI and adjust thinning accordingly. • Focus on competition status of FC trees; maintain species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SP / BI become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Follow species specific guidance for SP / BI dominated components. • Monitor light level, ground vegetation conditions, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.2.1 CP and shade tolerant conifers (XCST)

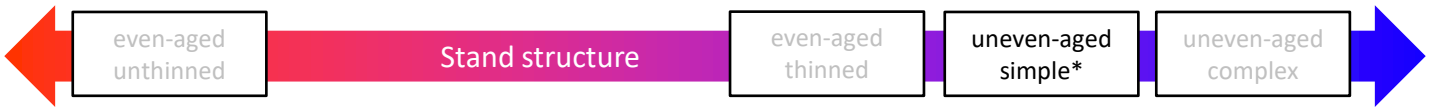


1. Structure and dynamics:

Stands with a CP overstorey and XCST understorey, but likely to become more structurally diverse over time. XCST options include WH, WRC, DF, firs, spruces and others; minor species of category A.

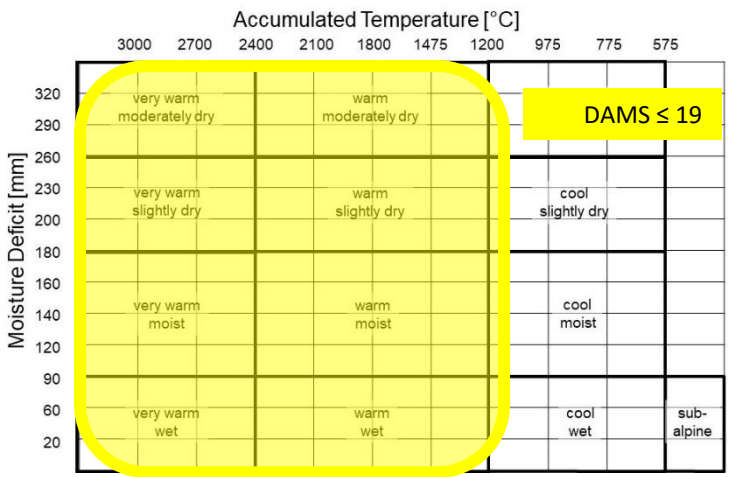
Species distribution: CP 30 – 70% XCST < 70% minor species: < 10%

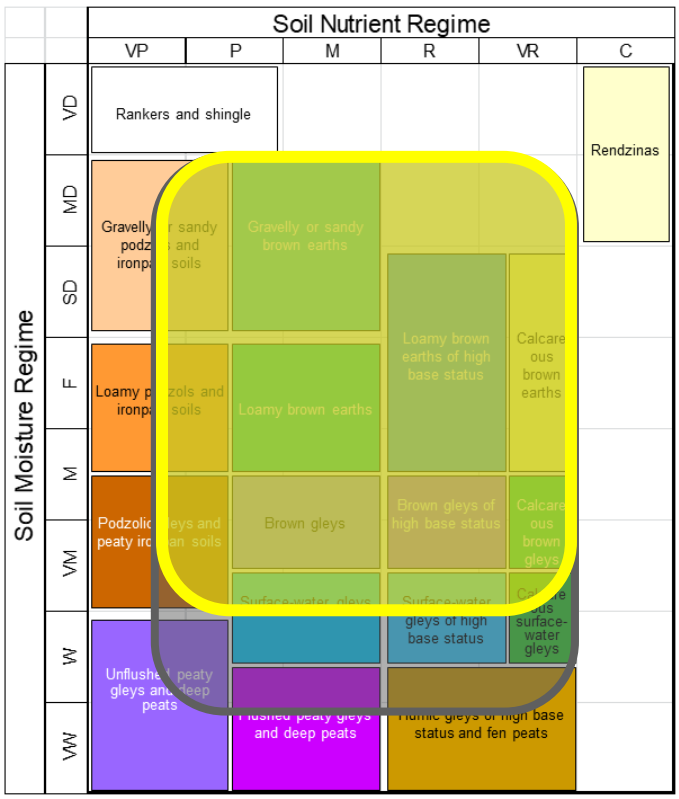
Stands will likely be the result of underplanting under CP and represent a transition stage towards a different FDT. Often several XCST species will be present and include emerging species; in these cases management objectives and future FDT will have to be reviewed and retain some flexibility.



2. Ecological suitability:

Represents no NVC type but may provide niches for elements of most lowland types. Appropriate for CP stands that are at risk of becoming infected with DNB and where XCST are introduced pre-emptively to increase resilience. Choice of XCST must be driven by site conditions and will result in different options for acidic and more calcareous sites.





3. Management objectives:

Economic:	CP – sawlogs, target DBH > 50cm in 60 – 100yrs XCST – sawlogs
Environmental and social:	Transition from CP to other FDTs avoiding the negative impacts of clearfelling and restocking.

FDT 2.2.1 CP and shade tolerant conifers (XCST)

4. General management principles for the FDT

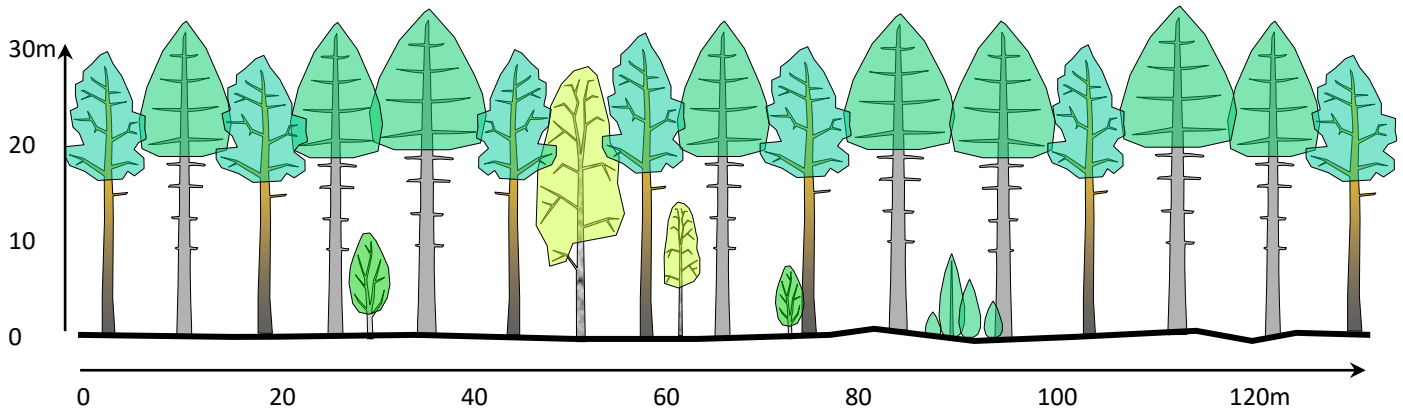
This FDT is designed to facilitate the transition from CP stands affected by DNB to XCST without the need for clearfelling. It also provides an option to introduce XCST species requiring sheltered growth conditions during their establishment phase. Species compatibility is not applicable to this FDT. Management must seek to maximise the benefits from the CP overstorey whilst developing the XCST understorey into a successor stand. Thinning of CP must aim to maintain tree health and steady growth as well as possible, whilst creating suitable conditions for the establishment and growth of the XCST understorey. XCST will usually be introduced by underplanting but some natural regeneration may be present. Underplanting may occur at variable ages but usually after sanitary thinnings in CP, leading to a distinct two-storey stand structure. Underplanting design must anticipate harvesting operations in order to avoid undue felling / extraction damage as thinning of CP continues alongside respacing and thinning of XCST. If several XCST species are introduced some thought should be given to their respective roles (i.e. primary / secondary species) in the future stand. Eventually XCST will encroach into CP canopy; at this point CP may be removed and the FDT must be reviewed.

5. Timeline

Please note that interventions up to Pole stage are usually not applicable to this FDT and have therefore been greyed out.

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary.
Thicket stage	3 – 10	• Generally no interventions, except for: • Systematic respacing if improved airflow is required by presence of DNB.
Pole stage	10 – 12	• First selective thinning (sanitary thinning), mainly removing trees with poor health status and opening canopy to increase air flow.
Pole to small timber stage	12 – 20	• Monitor health status of CP and continue thinning accordingly, at height growth intervals of 2 – 3m. Tree selection according to health status. • Establish XCST, usually by underplanting but taking advantage of any suitable natural regeneration present. • Open CP overstorey either continuously by removing individual rows or in strips by removing several adjacent rows, according to the specific light demand of XCST species. • Consider compatibility and role in future stand when underplanting with several XCST species. Compatible species (CS = 1) may be established as intimate mixtures, less compatible species (CS = 3) are better separated in robust groups. Use relevant XCST FDTs for guidance on species proportions.
Timber stage		• Monitor health status, stand density and stability of CP as well as light requirements of XCST understorey, and thin accordingly. • Respace and thin XCST according to species specific guidance. • Review FDT and plan for final harvesting of CP when XCST start growing into CP canopy and CP approaches target DBH.
Final harvesting and transition stage		• Carry out harvesting operations of CP according to agreed method. • Assess situation and decide on further management of XCST, following species specific guidance.

FDT 2.2.2 CP and light demanding conifers (XCLD)

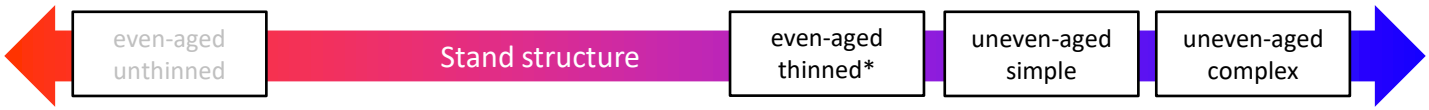


1. Structure and dynamics:

Mixed even-aged stands of CP and XCLD (SP or larches) where CP is likely to be phased out by the end of the current rotation. Minor species of category B. The species could be mixed intimately, in rows, small or large groups, or in patches. Supplemented by category B minor species.

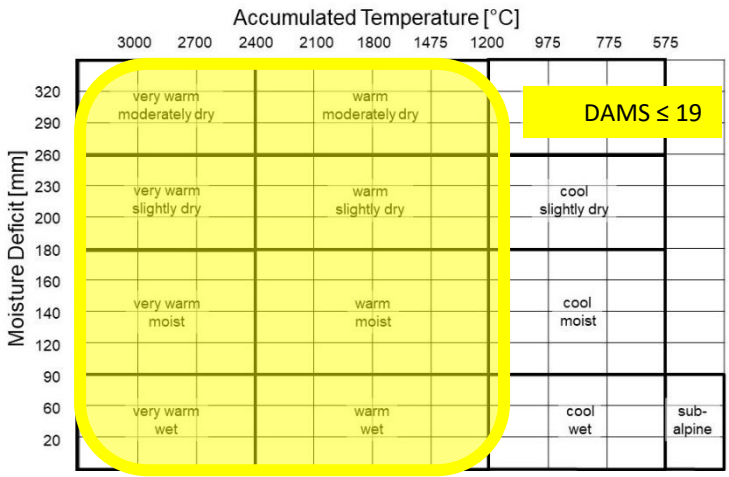
Species distribution: CP 30 – 90% XCLD 10 – 70% minor species: < 20%

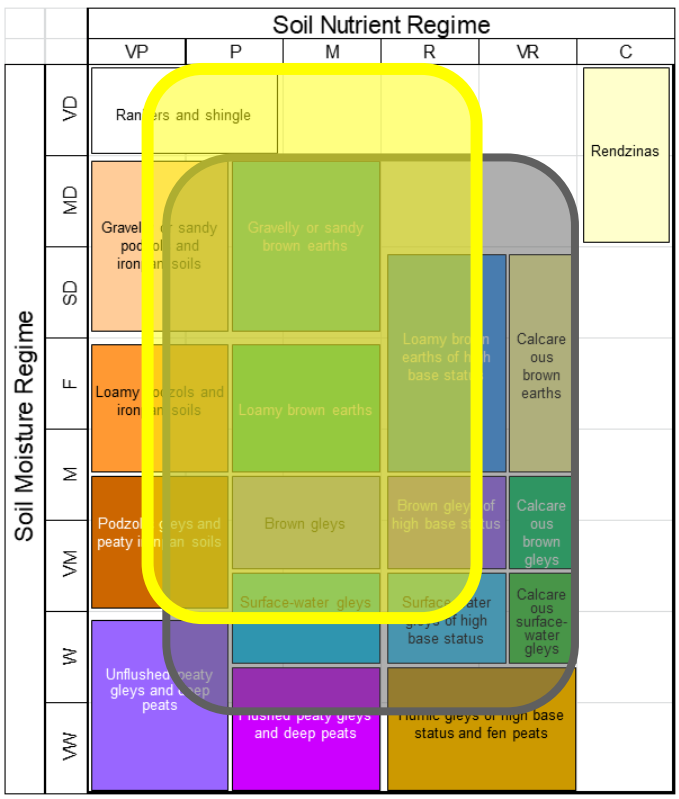
Management options include clearfell-and-restock as well as CCF / LIMA regimes and will lead towards a different FDT. Regeneration may happen naturally or by planting.



2. Ecological suitability:

Represents no NVC type but may contain elements of W18 and provide niches for minor species belonging into W17, W16 and W15. Appropriate for mixed CP stands that are at risk of becoming infected with DNB, mostly on poorer sites with sandy soil texture.





3. Management objectives:

Economic:	CP – sawlogs, target DBH > 40cm in 60 – 100yrs XCLD – sawlogs
Environmental and social:	Transition from CP to other FDTs. The XCLD component may provide an opportunity to do this without the negative impacts of clearfelling, thus better maintaining the environmental and social forest functions.

FDT 2.2.2 CP and light demanding conifers (XCLD)

4. General management principles for the FDT

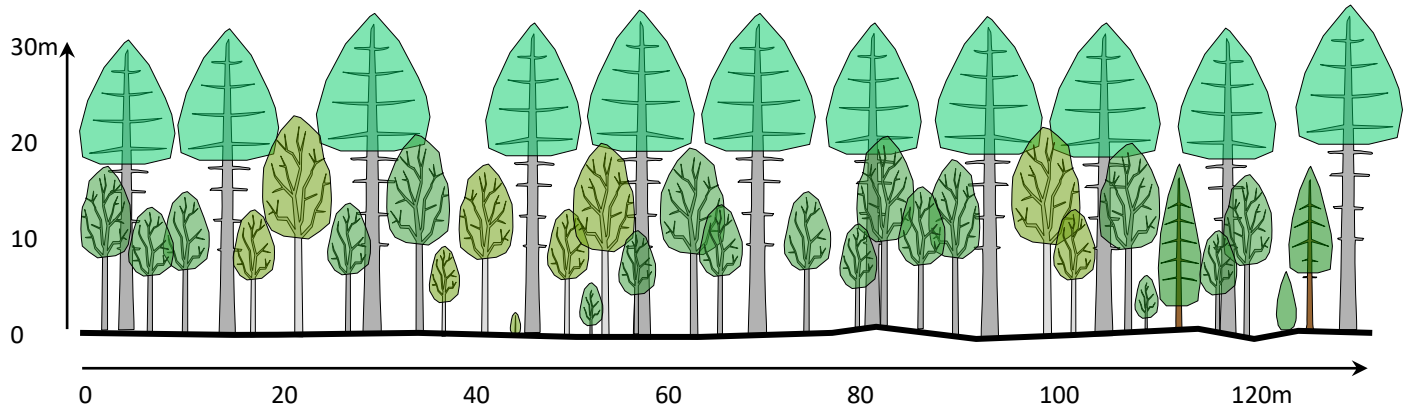
This FDT is designed to facilitate the transition from mixed CP stands affected by DNB to XCLD species. CP and XCLD are normally compatible to grow in mixtures (CS = 1 for other pines, CS = 2 for larches) but the health status of CP may negatively affect its competitiveness. Management must seek to phase out CP whilst developing the XCLD component into a viable stand. Depending on the proportion of CP and time available this may be possible by a relatively smooth process, or else require a more drastic approach. In any case thinning must aim to maintain CP tree health and steady growth as well as possible, whilst reducing its proportion in favour of XCLD species. If both objectives cannot be achieved simultaneously then the promotion of XCLD should take priority. Whilst LIMA / CCF methods are the preferable choice for final harvesting / restocking, a clearfell-and-restock scenario may provide a straightforward solution in cases where the potential for developing the existing XCLD component is too low. In any case the FDT must be reviewed once CP is phased out.

5. Timeline

Please note that interventions up to Thicket stage are usually not applicable to this FDT and have therefore been greyed out.

stage	H_{100} [m]	intervention
Establishment		• Underplanting of 2000 – 3000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary.
Thicket stage	3 – 10	• Generally no interventions, except for: • Systematic respacing if improved airflow is required by presence of DNB.
Pole stage	10 – 12	• First selective thinning. Sanitary thinning of CP, mainly removing trees with poor health status and opening canopy to increase air flow. Selective crown thinning of XCLD, mainly removing dominant / codominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 200 XCLD FC trees/ha. Healthy appearance of FC trees takes priority over all other criteria.
Pole to small timber stage	12 – 20	• Monitor health status of CP and continue thinning accordingly, at height growth intervals of 2 – 3m. • Generally promote XCLD over CP in tree selection for thinning. • Focus on competition status and healthy appearance of FC trees.
Timber stage		• Monitor health status of CP, stand density, species composition and stability in general, and thin accordingly. • Review FDT and plan for final harvesting / restocking when FC trees approach target DBH or CP expire.
Final harvesting and transition stage		• Carry out harvesting / restocking operations according to agreed method. • For LIMA / CCF options follow species specific guidance.

FDT 2.2.3 CP and long-lived broadleaves (XBLL)

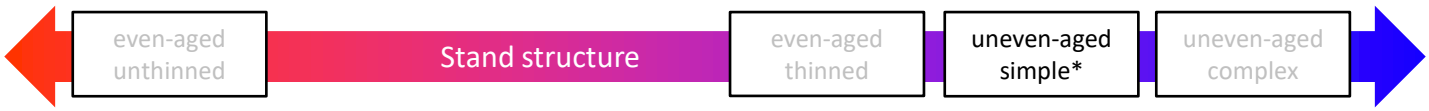


1. Structure and dynamics:

Stands with CP overstorey and XBLL understorey, but likely to become more structurally diverse over time. XBLL options include BE, OK, SY, SC, AH and others; minor species of category A.

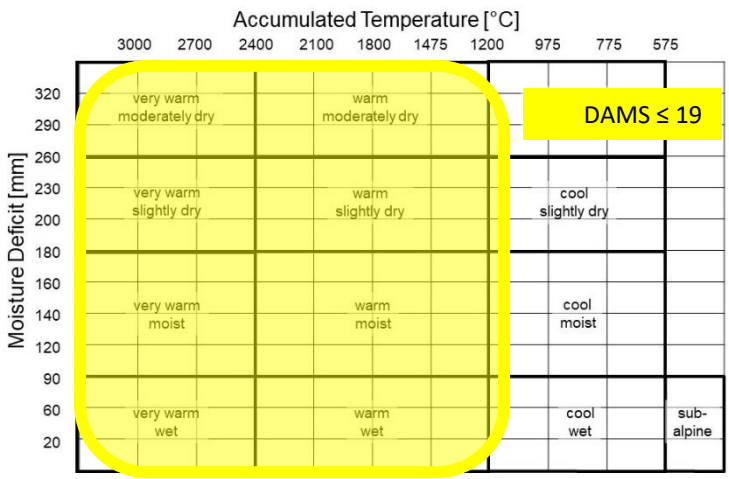
Species distribution: CP 30 – 70% XBLL 30 – 70% minor species: < 10%

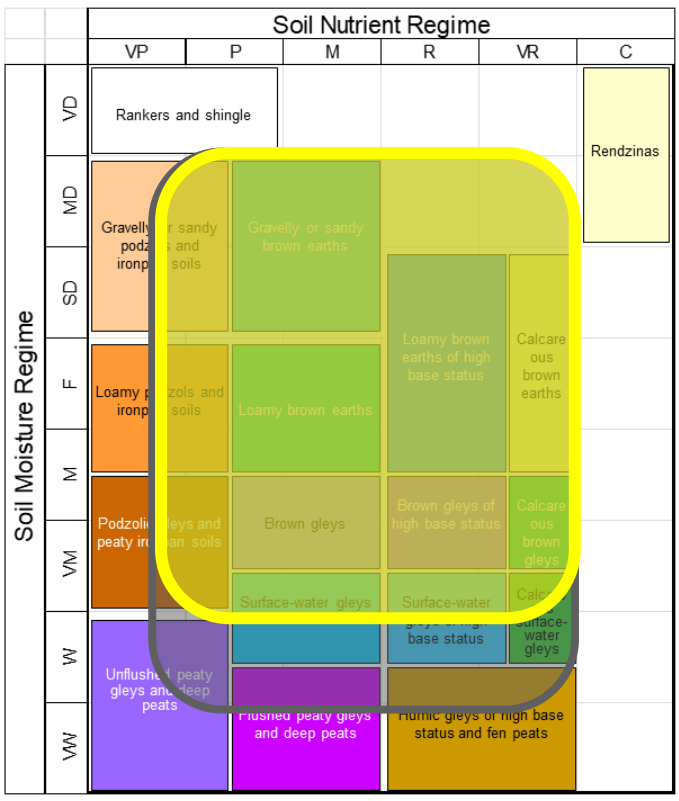
Stands will likely be the result of underplanting under CP and represent a transition stage towards a different FDT. Often several XBLL species will be present and include emerging species; in these cases management objectives and future FDT will have to be reviewed and retain some flexibility.



2. Ecological suitability:

Represents no NVC type but is likely to contain elements of most lowland types. Appropriate for CP stands at risk of becoming infected with DNB and where XBLL are introduced pre-emptively to increase resilience. Choice of XBLL must be driven by site conditions and will result in different options for acidic and more calcareous sites.





3. Management objectives:

Economic:	CP – sawlogs, target DBH > 50cm in 60 – 100yrs XBLL – sawlogs / pulp / chip
Environmental and social:	Transition from CP to other FDTs avoiding the negative impacts of clearfelling and restocking. XBLL elements are likely to improve soil fertility and increase the conservation value of the stand, particularly if native species are used.

FDT 2.2.3 CP and long-lived broadleaves (XBLL)

4. General management principles for the FDT

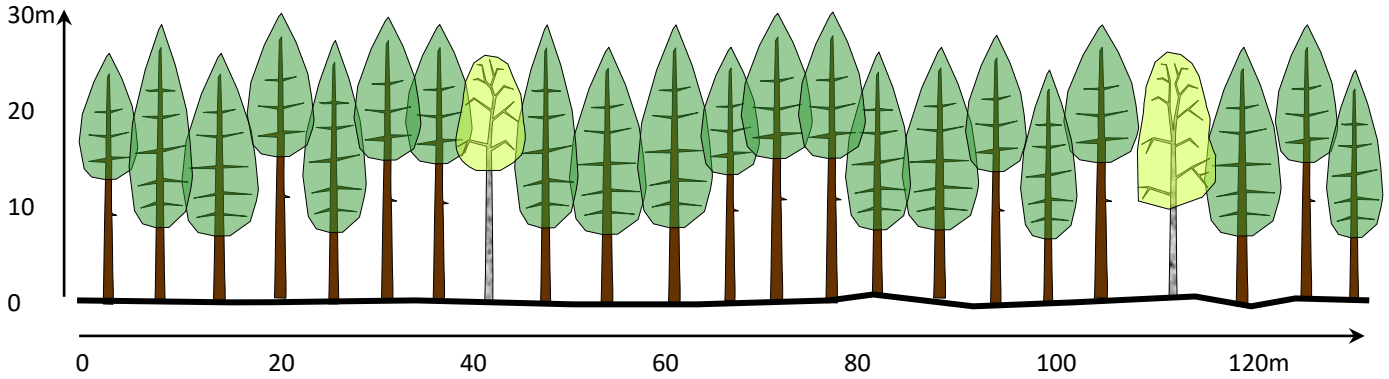
This FDT is designed to facilitate the transition from CP stands affected by DNB to XBLL without the need for clearfelling. It also provides an option to introduce XBLL species requiring sheltered growth conditions during their establishment phase. Species compatibility is not applicable to this FDT. Management must seek to maximise the benefits from the CP overstorey whilst developing the XBLL understorey into a successor stand. Thinning of CP must aim to maintain tree health and steady growth as well as possible, whilst creating suitable conditions for the establishment and growth of the XBLL understorey. XBLL will usually be introduced by underplanting but some natural regeneration may be present. Underplanting may occur at variable ages but usually after sanitary thinnings in CP, leading to a distinct two-storey stand structure. Underplanting design must anticipate harvesting operations in order to avoid undue felling / extraction damage as thinning of CP continues alongside respacing and thinning of XBLL. If several XBLL species are introduced some thought should be given to their respective roles (*i.e.* primary / secondary species, timber quality) in the future stand. Eventually XBLL will encroach into CP canopy; at this point CP may be removed and the FDT must be reviewed.

5. Timeline

Please note that interventions up to Pole stage are usually not applicable to this FDT and have therefore been greyed out.

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary.
Thicket stage	3 – 10	• Generally no interventions, except for: • Systematic respacing if improved airflow is required by presence of DNB.
Pole stage	10 – 12	• First selective thinning (sanitary thinning), mainly removing trees with poor health status and opening canopy to increase air flow.
Pole to small timber stage	12 – 20	• Monitor health status of CP and continue thinning accordingly, at height growth intervals of 2 – 3m. Tree selection according to health status. • Establish XBLL, usually by underplanting but taking advantage of any suitable natural regeneration present. • Open CP overstorey either continuously by removing individual rows or in strips by removing several adjacent rows, according to the specific light demand of XBLL species. • Consider compatibility and role in future stand when underplanting with several XBLL species. Although compatible species (CS = 1) may be established as intimate mixtures, for reasons of timber quality it is generally preferable to establish all XBLL in robust groups. Use relevant XBLL FDTs for guidance on species proportions.
Timber stage		• Monitor health status, stand density and stability of CP as well as light requirements of XBLL understorey, and thin accordingly. • Respace and thin XBLL according to species specific guidance. • Review FDT and plan for final harvesting of CP when XBLL start growing into CP canopy and CP approaches target DBH.
Final harvesting and transition stage		• Carry out harvesting operations of CP according to agreed method. • Assess situation and decide on further management of XBLL, following species specific guidance.

FDT 2.3.1 LP

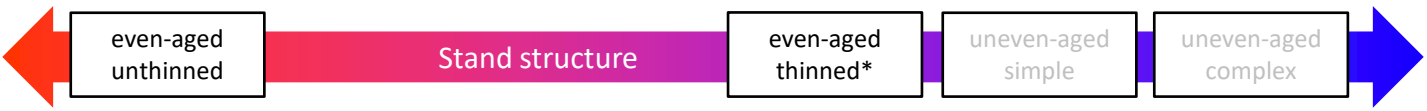


1. Structure and dynamics:

Even-aged, single-storied stands of LP with category B minor species.

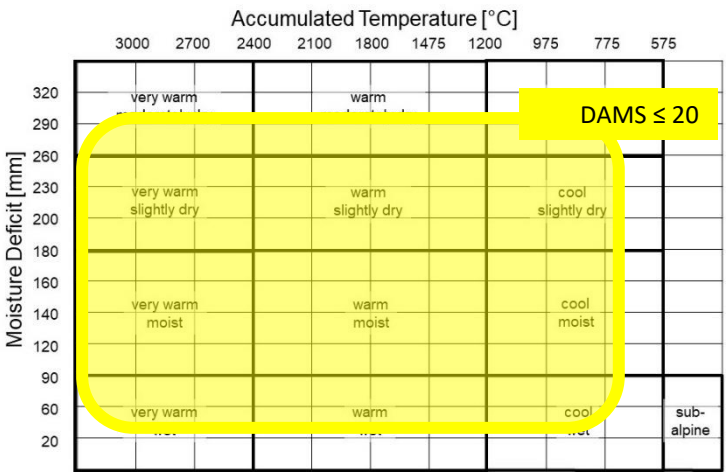
Species distribution: LP 90 – 100% minor species: < 10%

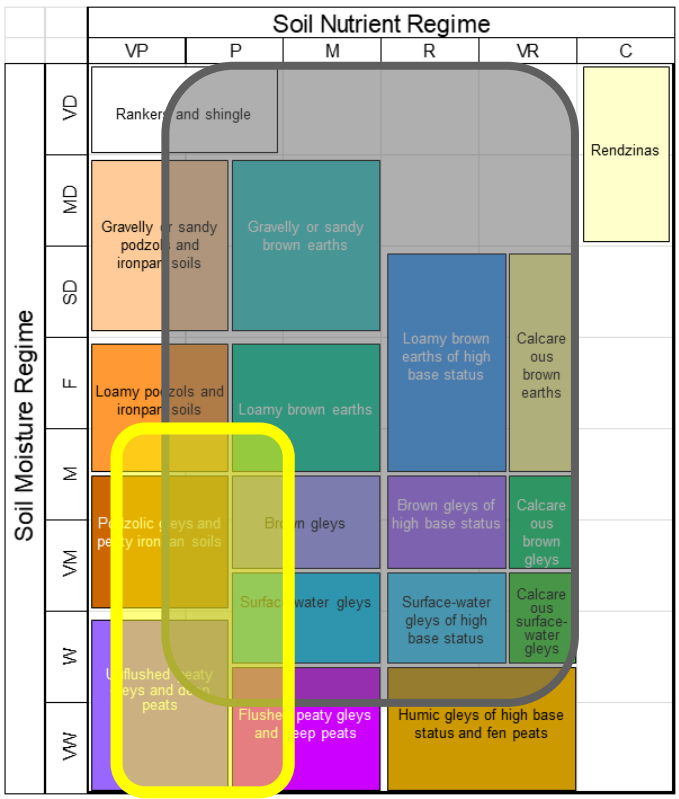
Stands are likely to be managed under clearfell-and-restock regimes, CCF / LIMA options could be considered. Natural regeneration should be used wherever possible if provenance is suitable.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of W4 and W18. Appropriate for wet, poor and peaty sites where there is no commercial conifer alternative to LP, yet forest cover is desirable and in line with policy.





3. Management objectives:

Economic: LP – sawlogs / pulp / chip

Environmental and social: Important option for peatland edge woodland habitats, with minor species elements further increasing stand diversity and improving stability with regard to risk factors. Soil and water retention may be an important objective on some sites. CCF / LIMA methods may provide opportunities to minimise peat disturbance.

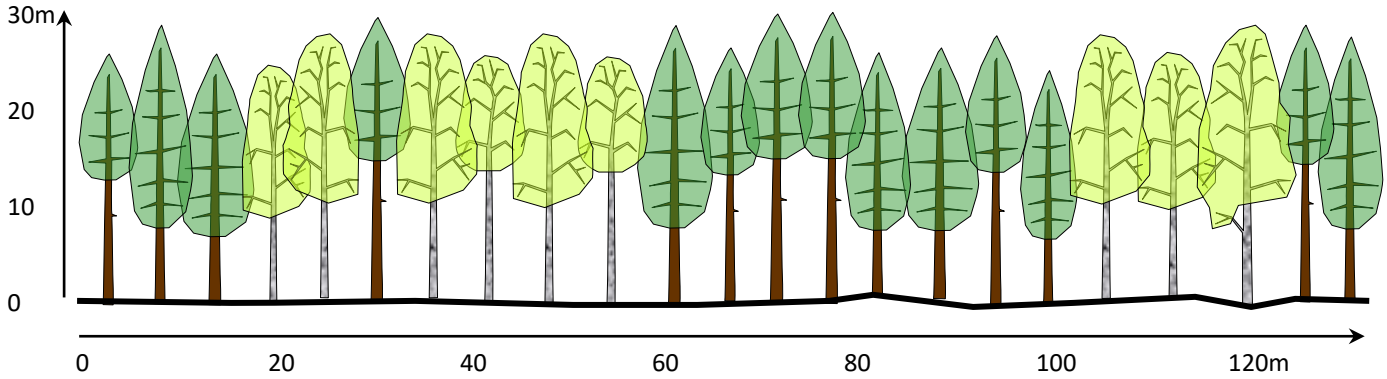
4. General management principles for the FDT

This FDT has been designed to produce even-aged stands of LP growing on wet and peaty soils of low fertility where LP can deliver management objectives and is without alternatives due to the difficult site conditions. Management of young stands should aim to achieve canopy cover and maintain even and rapid growth of all stand components. Developing good tree stability is also important if the stand is to be thinned. A no thinning approach is possible but will limit management options and achievable target DBH. Stands originating from dense natural regeneration are likely to require respacing in order to develop individual tree stability. The growth response of LP to thinning interventions peaks early in life and diminishes rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Thinning should start at 10 – 12m top height, generally as crown thinning. Thinning at later stages must aim to maintain an even canopy cover and steady growth; thinning type may change to low. Although clearfell-and-restock is the main management system envisaged, opportunities for natural regeneration should be used wherever possible. Review of FDT at time of final harvesting.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Careful choice of provenance is important.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of dominant trees.
Timber stage		• Monitor crown length, h/d ratio (stability indicators), BA and canopy cover (competition indicators) and thin accordingly. Reduce thinning intensity and / or lengthen thinning cycles as LP becomes less responsive to thinning. • Apply crown thinning as long as necessary for benefits of dominant trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when dominant trees reach target DBH. • Assess potential for natural regeneration and improve conditions if necessary, review suitability of FDT and consider LIMA / CCF methods as appropriate.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

FDT 2.3.2 LP and DBI

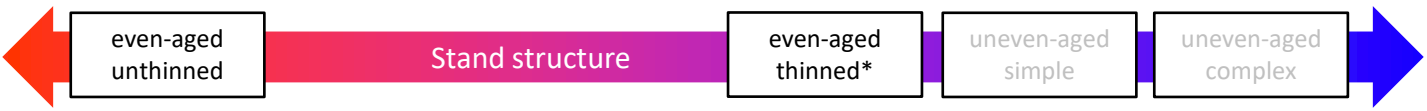


1. Structure and dynamics:

Even-aged, single storey stands of LP and BI, with category A minor species. Species mixing could be intimate, in small or large groups, or in patches.

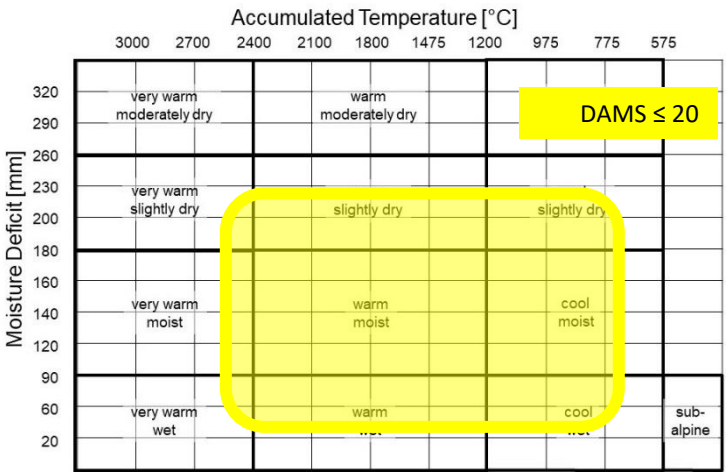
Species distribution: LP 50 – 70% DBI 30 – 50% minor species: < 10%

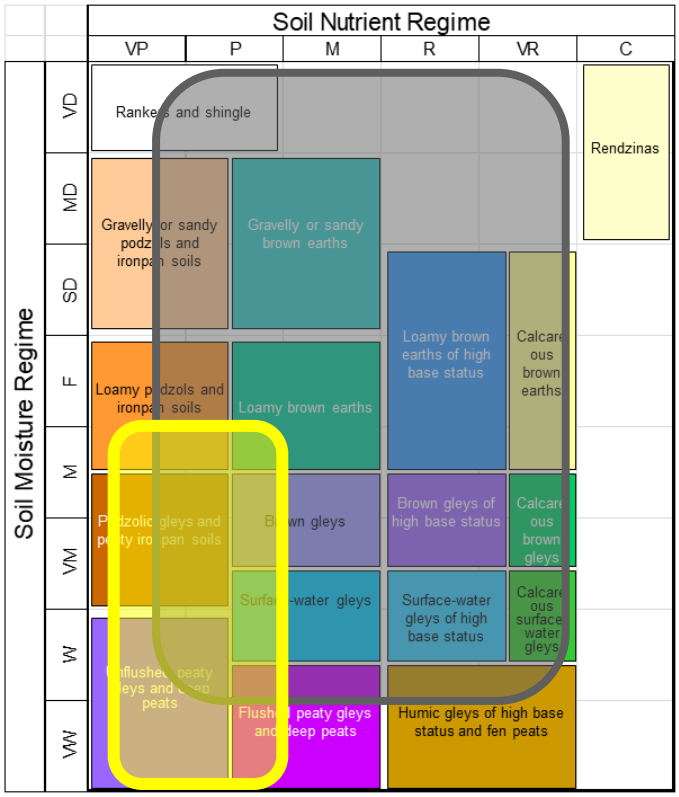
Management is likely to be by LP clearfell-and-restock scenario with BI natural regeneration infill. Natural regeneration of LP may also occur and should be used wherever possible. CCF / LIMA options are possible.



2. Ecological suitability:

Represents no NVC type but contains components of W4 and provides niches for elements of W18. Appropriate for wet, poor and peaty sites where there is no commercial conifer alternative to LP, yet forest cover is desirable and in line with policy.





3. Management objectives:

Economic:	LP – optional, sawlogs / pulp / chip BI – optional
Environmental and social:	Important option for peatland edge woodland habitats, with BI and minor species further increasing stand diversity and improving stability with regard to risk factors. Soil and water retention may be an important objective, and CCF / LIMA methods can provide opportunities to minimise peat disturbance. BI acts as a soil improver.

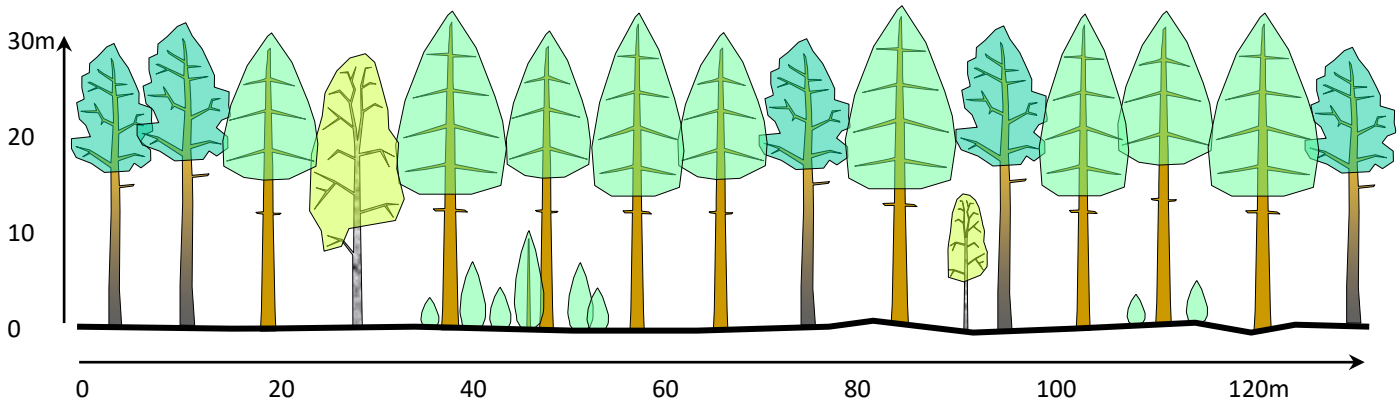
4. General management principles for the FDT

This FDT is for productive stands of LP growing on wet and peaty soils of low fertility where LP can deliver management objectives and where higher structural and species diversity than in FDT 2.3.1 is desirable. The role of DBI in this FDT is mainly for environmental and social benefits, however economic opportunities arising from biomass / timber production should be used wherever possible. If DBI is to be grown to sawlog dimensions respacing and thinning must ensure that the relative length of the live crown never drops below 60% of tree height. As pioneer species LP and DBI are quite compatible (CS = 2) to grow in mixtures, with growth rates peaking early in life and diminishing rapidly thereafter. Management of young stands should aim to achieve canopy cover and maintain even and rapid growth of all stand components. Developing good tree stability is also important if the stand is to be thinned. A no thinning approach is possible but will limit management options and achievable target DBH. Thinning should start at 10 – 12m top height, generally as crown thinning. Thinning at later stages must aim to maintain an even canopy cover and steady growth; thinning type may change to low. Although clearfell-and-restock is the main management system envisaged, opportunities for natural regeneration should be used wherever possible.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha considering choice of LP provenance; DBI often from natural regeneration. • If DBI is planted, establishment in robust groups is preferable.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between SP and BI and adjust thinning accordingly. • Focus on competition status of dominant trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Reduce thinning intensity and / or lengthen thinning cycles as LP / DBI become less responsive to thinning. • Apply crown thinning as long as necessary for benefits of dominant trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when dominant trees approach target DBH. • Assess potential for natural regeneration and improve conditions if necessary, review suitability of FDT and consider LIMA / CCF methods as appropriate.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

FDT 2.4.1 LA and SP

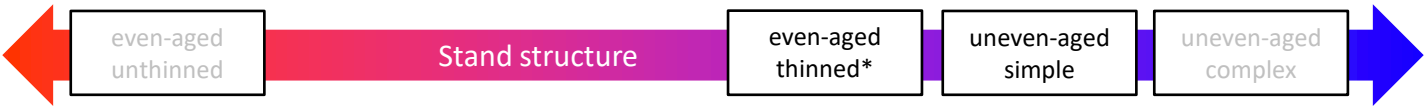


1. Structure and dynamics:

Single-storied stands of LA (preferably EL), with a component of SP and category B minor species. Mixture type ranges from intimate to small areas.

Species distribution: LA 60 – 90% SP 10 – 40% minor species: < 10%

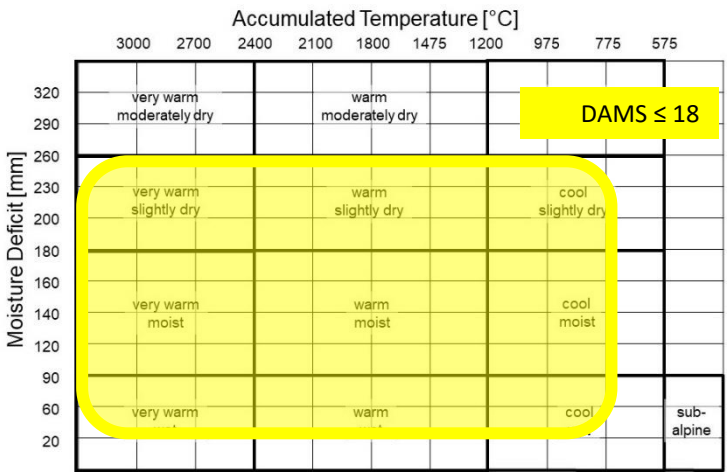
Management may be by clearfell-and-restock or LIMA / CCF methods using natural regeneration as far as possible, but must take account of the light demanding nature of the species.

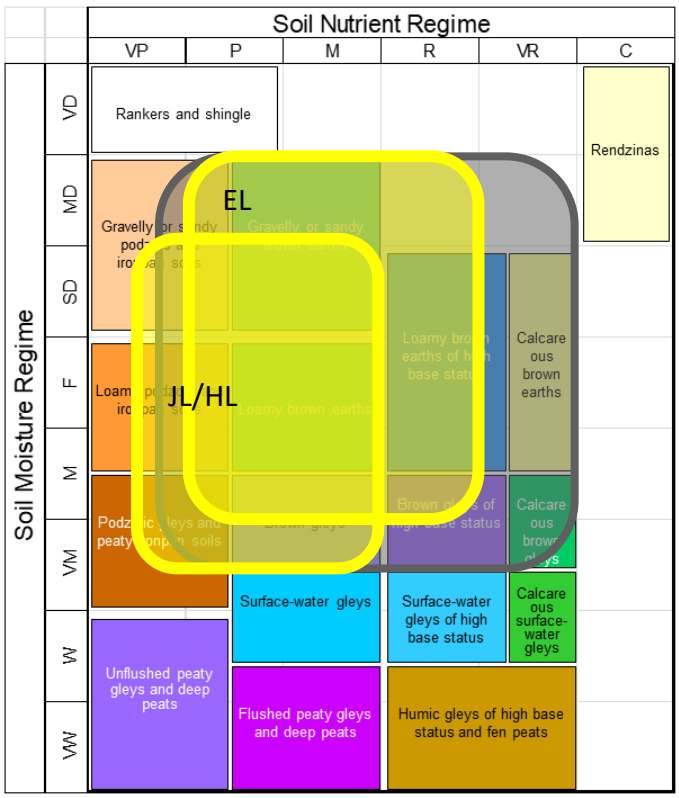


2. Ecological suitability:

Contains elements of NVC type W18 and provides niches for components of W17, W11, W15 and W16. Appropriate on poorer sites with sandy to loamy soil texture where LA achieves GYC < 10 and there are few alternative secondary species other than SP.

Unsuitable for frost hollows and sites of low air circulation.





3. Management objectives:

Economic: LA – sawlogs, target DBH > 40cm in 80 – 120yrs
SP – sawlogs, target DBH > 50cm in 100 – 140yrs

Environmental and social: The SP component increases stand diversity and helps mitigating against the risk of disease in pure LA stands. Bright and visually attractive stands with a mix of species and autumn colour provide a good environment for recreation and amenity.

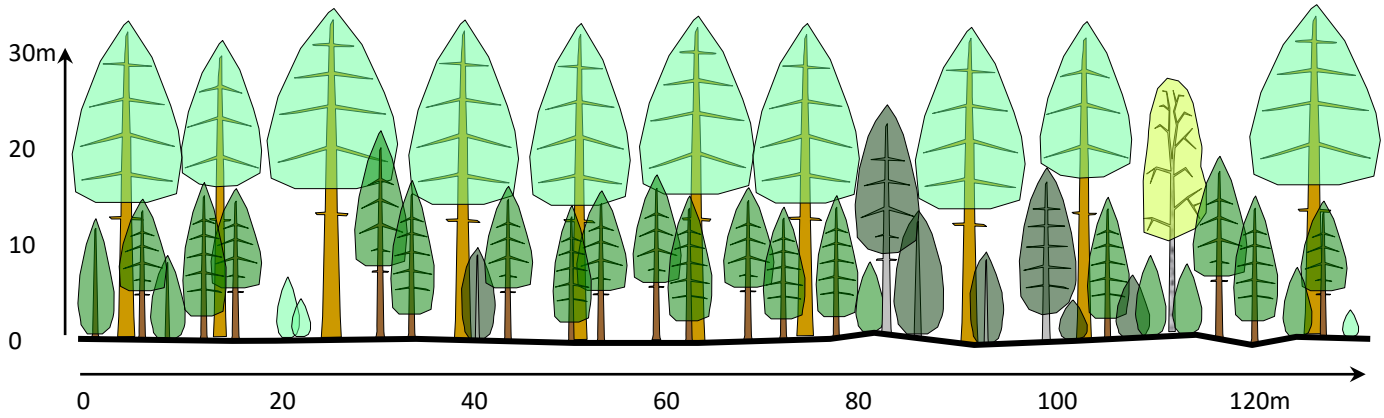
4. General management principles for the FDT

LA and SP are quite compatible (CS = 2) to grow in mixed stands, however mixture design requires some attention to account for the different growth rate of both species. Management of young stands should aim to develop tree stability, timber quality and achieve even and rapid growth. LA and SP follow a similar pattern with growth responding strongly to thinning interventions early in life and diminishing rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Thinning should start at 10 – 12m top height, generally as crown thinning. Despite their similar growth pattern, LA and SP require regular monitoring and corrective action taken quickly should one species outgrow and dominate the other. Thinning at later stages must aim to maintain tree stability, target species composition and steady growth. Clearfell-and-restock as well as simple LIMA / CCF methods such as strip, seed tree and fast shelterwood systems provide options for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. • LA – systematic respacing to ≤ 2000 trees/ha. • SP – negative selective respacing (removal of wolf tree candidates). • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 150 – 300 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha (LA + SP). • Pruning of some FC trees may be considered.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as LA / SP become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Consider LIMA / CCF methods and assess potential for natural regeneration, improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • In shelterwood scenarios, reduce BA to 20 – 25m^2/ha initially and then further once regeneration has established. • Design strip systems with regard to prevailing wind direction and climatic requirements of LA / SP regeneration; keep strip width < 50m. • In seed tree scenarios, retain 20 – 50 seed trees/ha into second rotation. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.4.2 LA and shade tolerant conifers (XCST)

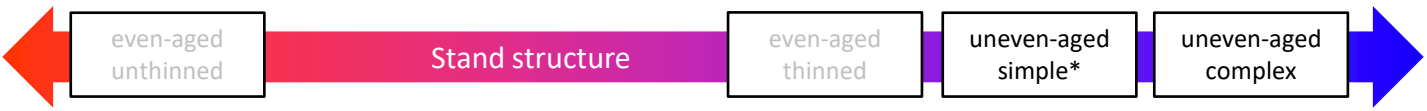


1. Structure and dynamics:

Stands initially with a LA overstorey and XCST understorey, but likely to become more structurally diverse over time. XCST options include WH, WRC, DF, firs, spruces and others; minor species of category A.

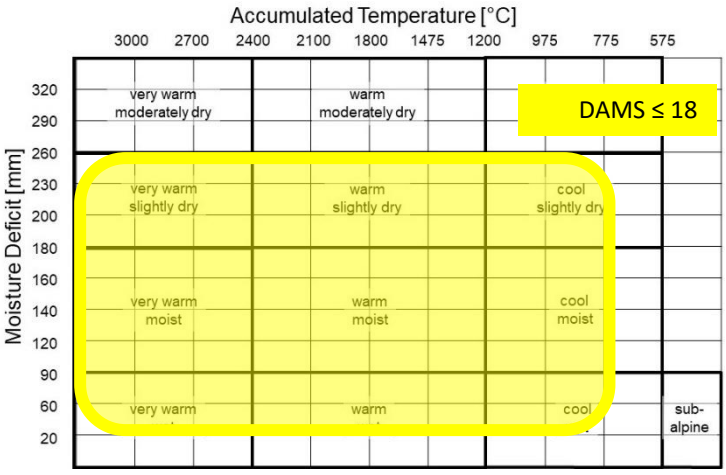
Species distribution: LA 60 – 80% XCST 20 – 40% minor species: < 10%

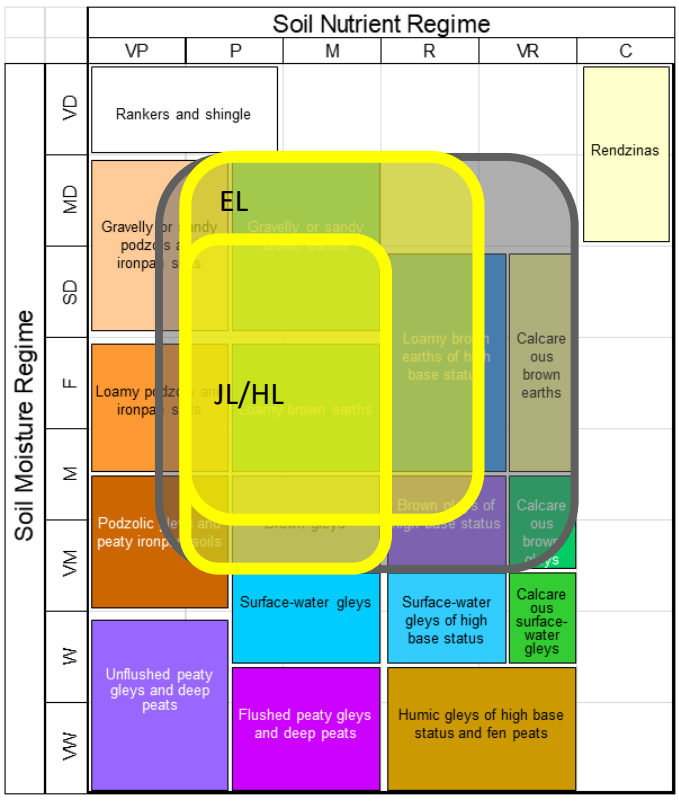
Several XCST species may be present and include emerging species. CCF / LIMA techniques are likely to be adopted in order to maximise the use of natural regeneration. Management objectives and future FDT will have to be reviewed, particularly where there is a high disease risk with LA.



2. Ecological suitability:

Represents no NVC type but may provide niches for elements of most upland and lowland types. A good option to mitigate against disease risk to LA on sites where timber productivity is an important objective. Appropriate on medium fertility sites with loamy soil texture where LA achieves GYC > 8. Unsuitable for frost hollows and sites of poor air circulation.





3. Management objectives:

Economic:	LA – sawlogs, target DBH > 50cm in 80 – 120yrs XCST – logs / pulp / biomass
Environmental and social:	The XCST component adds diversity and mitigates against disease risk in LA. Stands are visually attractive due to their structure, mix of species and contrasting colours, thus enhancing value for recreation and amenity.

FDT 2.4.2 LA and shade tolerant conifers (XCST)

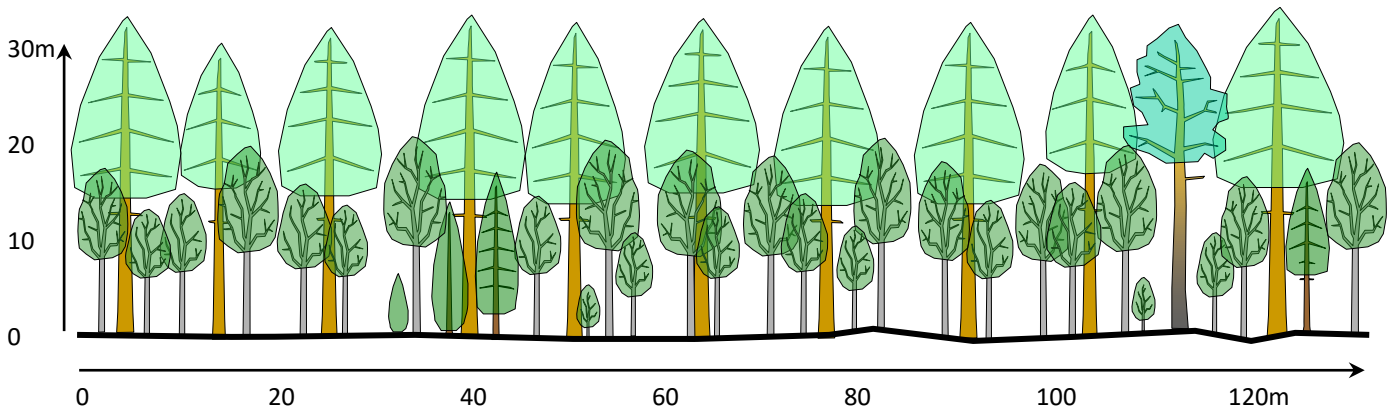
4. General management principles for the FDT

This FDT is for productive LA stands of high timber quality. Due to their high light demand, low shade casting and relatively long rotation required to achieve large timber dimensions, LA are very suitable species to be underplanted. The role of XCST is to add productivity and diversity whilst controlling ground vegetation. The XCST component will be established by natural regeneration or underplanting after the early thinning phase in LA, leading to a distinct two-storey stand structure. Species compatibility is therefore irrelevant but careful timing of XCST establishment is important to prevent the understorey from growing into the LA canopy too soon. The growth response of LA to thinning interventions peaks early in life and diminishes rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Management of LA similar to FDT 2.4.1. XCST will eventually catch up with LA in height growth, at this point the FDT needs to be reviewed. Further management will depend on the decision of continuing with a LA dominated FDT or switching to XCST; in either case LIMA / CCF methods should be the preferable option for final harvesting / restocking.

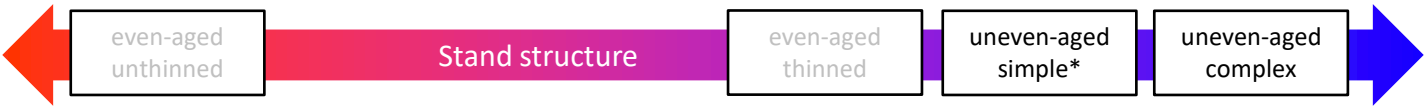
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 1500 – 2500 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 150 – 300 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha, consider pruning.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as LA becomes less responsive to thinning. • Establish XCST, either by natural regeneration or underplanting. Stocking density may be slightly lower than in open ground scenarios. • Respace and thin XCST according to species specific guidance. • Review FDT and plan for final harvesting when XCST start growing into LA canopy and LA FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

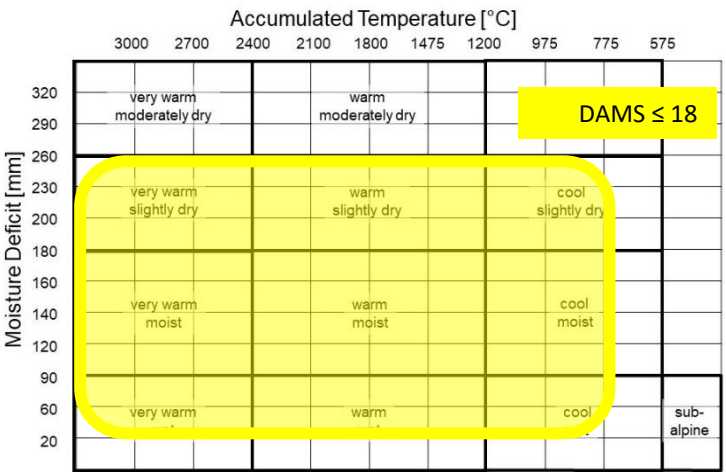
FDT 2.4.3 LA and BE

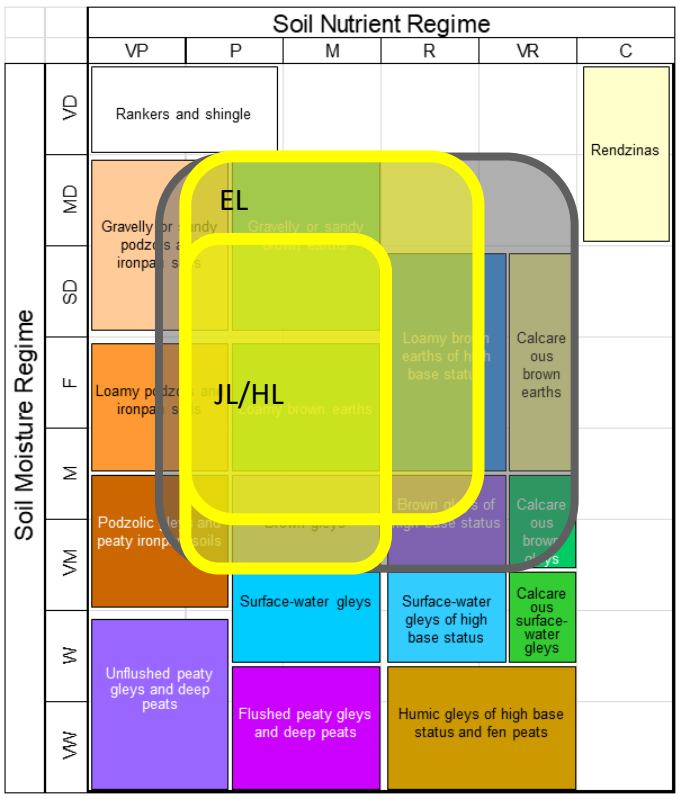


1. Structure and dynamics:
Initially two-storeyed stands of LA (preferably EL) overstorey and BE understorey, but likely to develop a more complex structure later. Minor species of category B.
Species distribution: LA 50 – 80% BE: 10 – 40% minor species: < 10%
Likely to originate from LA underplanted with BE. Management via LIMA / CCF systems offers options to use natural regeneration, however clearfell-and-restock scenarios are also possible.



2. Ecological suitability:
Represents no current NVC type but contains substantial elements of W14 and W15. This FDT should be considered to mitigate disease risk, to add productivity in good quality LA stands and to facilitate the transition from LA to broadleaved stands via CCF. Suitable for soils of better fertility and loamy texture. Unsuitable for frost hollows and sites of poor air circulation.





3. Management objectives:
Economic (LA GYC > 8): LA – joinery grade, target DBH > 70cm in 100 – 140yrs
LA – sawlogs, target DBH > 50cm in 80 – 120yrs
BE – optional, sawlogs, target DBH > 50cm in 60 – 120yrs
Environmental and social: Attractive woodland due to mixture type and spring / autumn aspect. BE component adds diversity, acts as soil improver, controls ground vegetation and thus facilitates natural regeneration of LA.

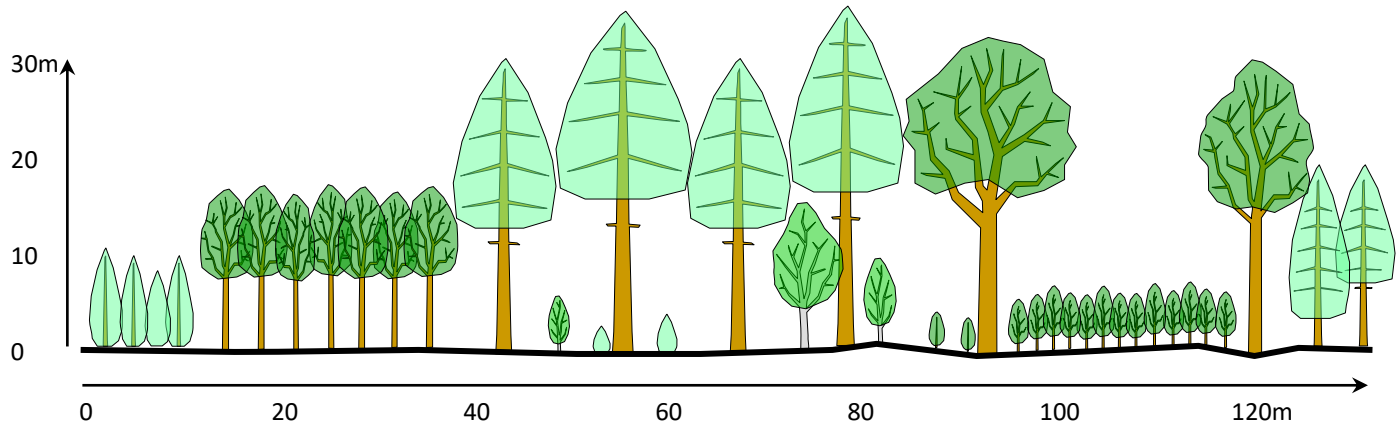
4. General management principles for the FDT

This FDT is for productive LA stands of high timber quality. Due to their high light demand, low shade casting and relative long rotation required to achieve large timber dimensions, LA are very suitable species to be underplanted. The role of BE is to add productivity and diversity whilst controlling ground vegetation. The BE component will be established by natural regeneration or underplanting after the early thinning phase in LA, leading to a distinct two-storey stand structure. Species compatibility is therefore irrelevant but careful timing of BE establishment is important to prevent the understorey from growing into the LA canopy too soon. The growth response of LA to thinning interventions peaks early in life and diminishes rapidly thereafter; thinning must therefore not be unduly delayed and should focus on pole and small timber stage. Management of LA similar to FDT 2.4.1. BE will eventually catch up with LA in height growth, at this point the FDT needs to be reviewed. Further management will depend on the decision of continuing with a LA dominated FDT or switching to BE; in either case LIMA / CCF methods should be the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 1500 – 2500 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 150 – 300 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha, consider pruning.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as LA becomes less responsive to thinning. • Establish BE, by natural regeneration or underplanting. Stocking density may be slightly lower than in open ground scenarios. • Respace and thin BE according to guidance in FDT 6.1.1 / 6.1.2. • Review FDT and plan for final harvesting when BE start growing into LA canopy and LA FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 2.4.4 LA and OK

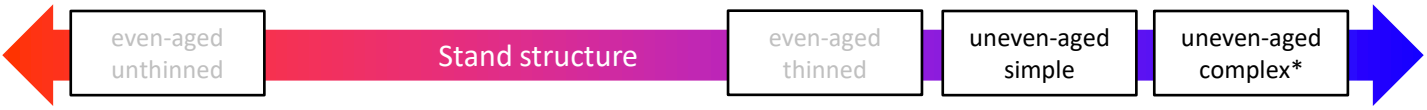


1. Structure and dynamics:

Mosaic of single-storeyed large groups or patches of LA and OK (preferably SOK) of variable age, with individual trees or small groups of category B minor species.

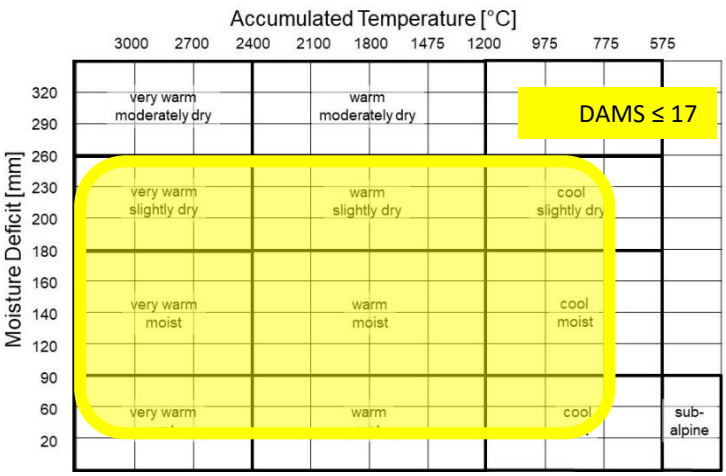
Species distribution: LA 50 – 70% OK: 20 – 40% minor species: 10 – 20%

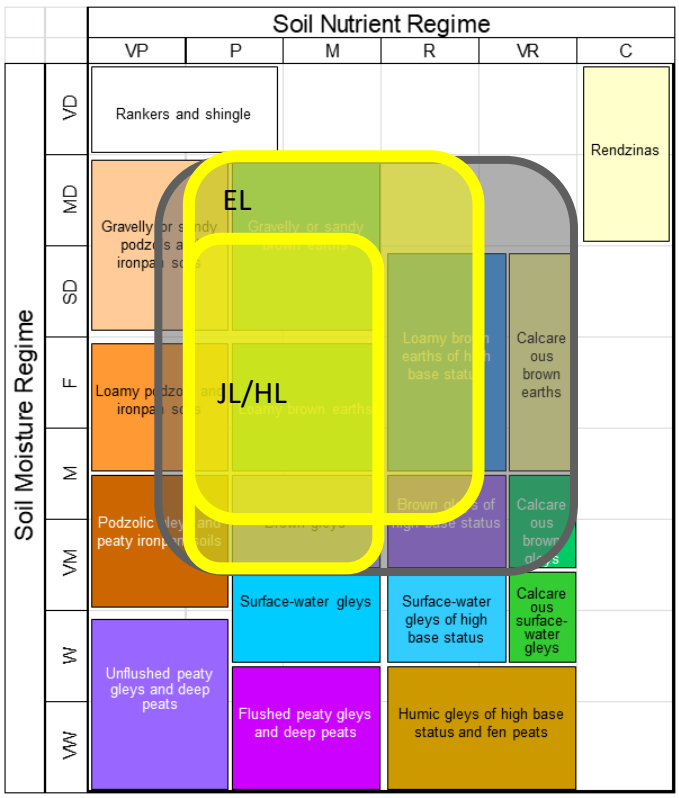
LA and OK will be managed using LIMA with single species cohorts on different rotations. LA should propagate via natural regeneration, OK may be planted if regeneration is insufficient.



2. Ecological suitability:

Contains important elements of NVC types W10, W11, W16 and W17. Similar to FDT 2.1.5 (SP and OK) but appropriate for more fertile sites with loamy soil texture, where LA achieves GYC > 8 and productive OK is also an option. Unsuitable for frost hollows and sites of poor air circulation. A good option to mitigate disease risk for LA.





3. Management objectives:

Economic: LA – sawlogs, target DBH > 60cm in 80 – 120yrs
OK – sawlogs, target DBH > 60cm in 140 – 180yrs

Environmental and social: A good option for sites where timber productivity and biodiversity are both important objectives. OK increases biodiversity and improves soil quality. Attractive stands with a diverse structure, interesting mix of species and autumn colour, providing a good environment for recreation and amenity.

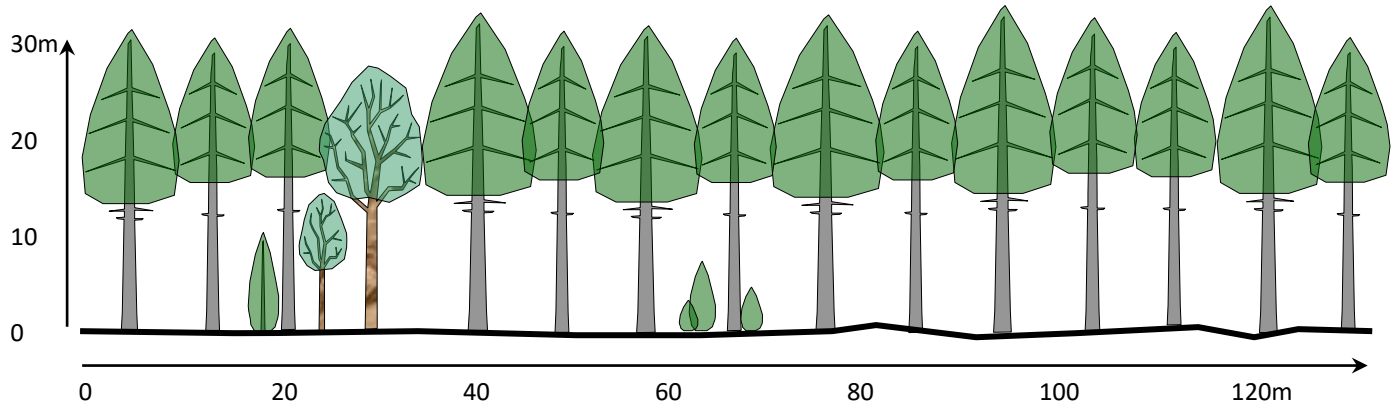
4. General management principles for the FDT

LA and OK are not that compatible (CS = 3) to grow in mixture, so attention to mixture design is required – the faster growth rate of LA must be compensated by deploying the OK in groups or rows. This FDT therefore aims to create a small scale mosaic of more or less even-aged cohorts of LA and OK. Whilst the early peak of growth rate in LA requires early and heavy interventions, timber quality in OK benefits from high initial stocking density and requires careful quality selection during respacing and thinning. Thinning in LA should start at around 10 – 12m top height and focus on pole and small timber stage, thinning in OK may start slightly later once a clean bole of > 6m has been achieved through self-pruning. For both species crown thinning should be applied throughout. Thinning at later stages must aim to maintain tree stability and steady growth. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 1500 – 2500 (LA) and 5000 – 10000 (OK) trees/ha or natural regeneration. Whilst individual LA may be embedded in a surrounding matrix of OK, OK should be established in patches, large groups or at least in robust clusters of > 25 trees planted at tight spacing.
Young stand	< 3	• Protection against animals / plants as necessary. • LA – systematic respacing if N > 3000 trees/ha at 1 – 2m tree height. • OK – negative selective respacing only (removal of undesirable trees). • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing and careful promotion of 150 – 300 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning in LA, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha (LA + OK). • Pruning of some LA FC trees may be considered, OK should self-prune.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between LA and SOK and adjust thinning accordingly. • Thinning in groups of OK should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as LA / OK become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Follow species specific guidance for LA / OK dominated components. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 3.1.1 DF

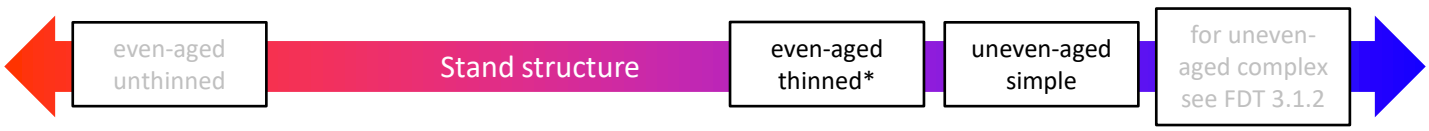


1. Structure and dynamics:

Single-storeyed DF stands with category A minor species, admixed individually or in groups on microsites unsuitable for DF.

Species distribution: DF 90 – 100% minor species: < 10%

Stands will largely be managed under clearfell-and-restock regime, with minor species regenerating naturally. Natural regeneration of DF should be used wherever possible, and CCF / LIMA options are a practical alternative to clearfelling if conditions are favourable.

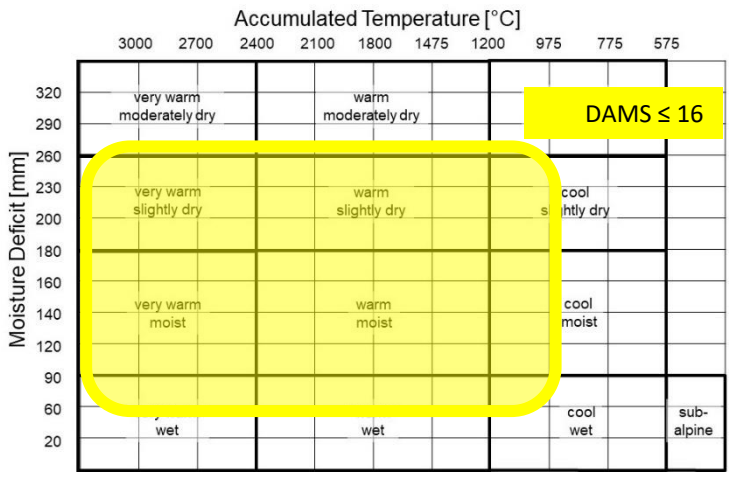


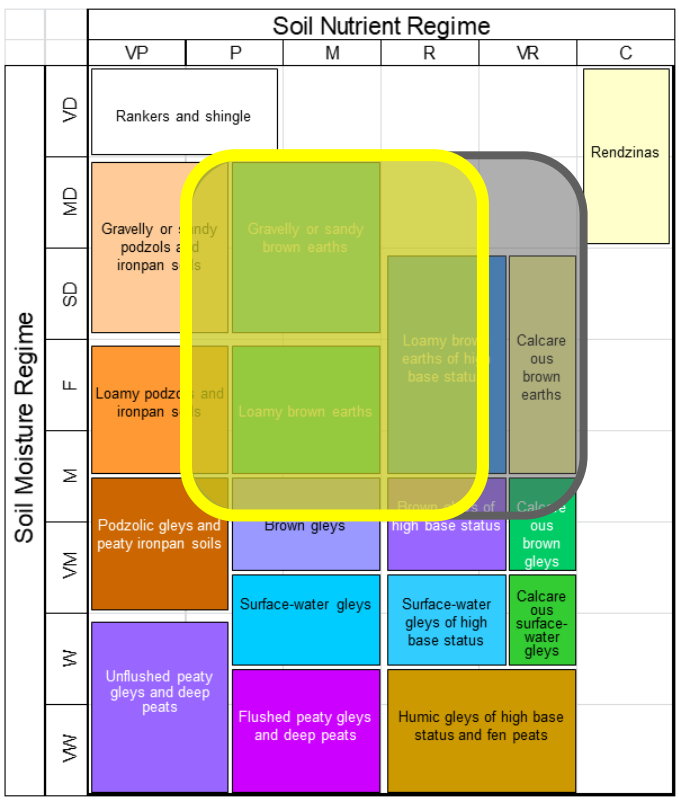
2. Ecological suitability:

Represents no NVC type but provides niches for elements of W10, W11, W15, W16 and W17.

Appropriate on sheltered sites with well aerated soils of sandy to loamy texture, suitable for droughty soils.

Unsuitable for exposed sites and frost hollows.





3. Management objectives:

Economic: DF – sawlogs, target DBH > 60cm in 60 – 100yrs

Environmental and social: Soil and water retention may be an important objective on droughty sites. Mature stands are attractive and popular for amenity and recreation. Minor species elements increase habitat diversity and improve soil quality.

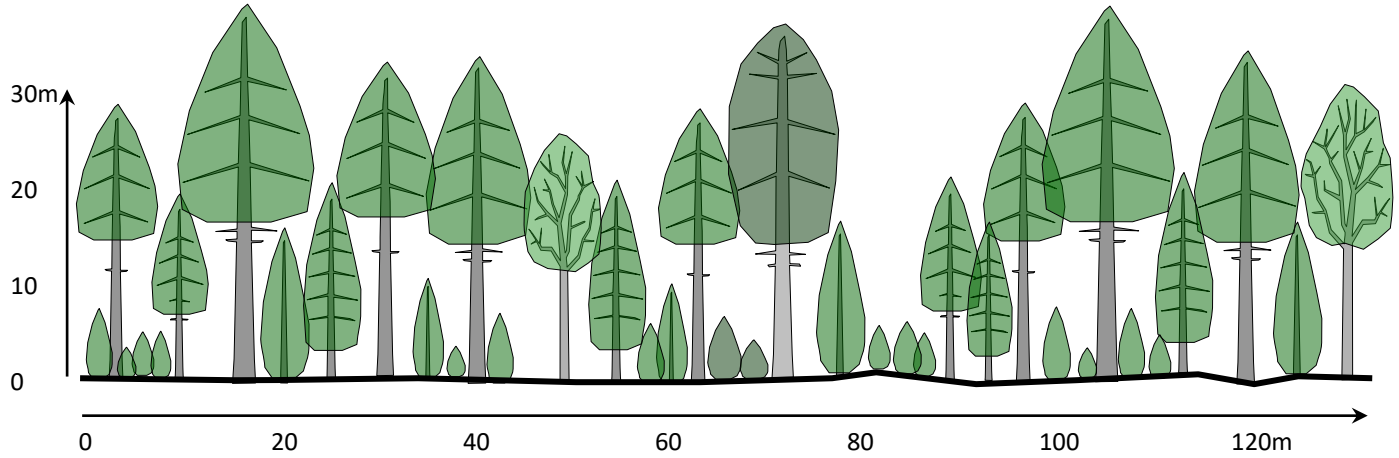
4. General management principles for the FDT

This FDT should be used where clearfell-and-restock scenarios with DF are envisaged, either because this suits the site specific management objectives or because sufficient natural regeneration of DF cannot be expected. In the latter case a review of the FDT may be required. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Stands originating from dense natural regeneration are likely to require respacing. DF will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Crown thinning should be used as long as necessary to develop good individual tree stability, however the thinning type may eventually shift towards low thinning, particularly in more exposed areas. DF can regenerate well under its own canopy if conditions are right and therefore LIMA / CCF methods should be considered for final harvesting / restocking on suitable sites. During the rotation there may be opportunities for species diversification and, if taken, the FDT may need to be reviewed.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Due to the wide natural range of DF careful choice of provenance is important.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 200 – 300 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Assess potential for natural regeneration and consider LIMA / CCF methods, improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • In shelterwood scenarios, reduce BA to 30 m^2/ha initially and then further once regeneration has established itself. • Design strip systems with regard to prevailing wind direction and climatic requirements of DF regeneration; keep strip width < 50m. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 3.1.2 DF



1. Structure and dynamics:

Single to multiple-storeyed DF stand with category A minor species, individually or in groups, mostly occupying the understorey as well as suitable microsites and areas of difficult access.

Species distribution: DF 80 – 90% minor species: 10 – 20%

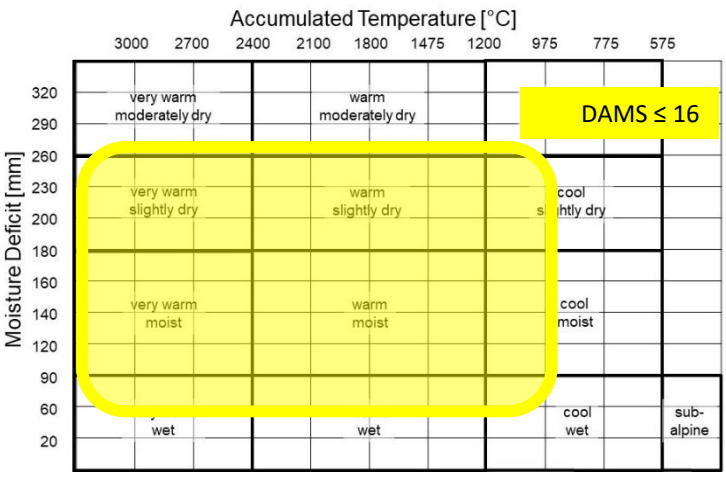
Stands should be managed under LIMA or CCF regimes, aiming to create a complex stand structure.

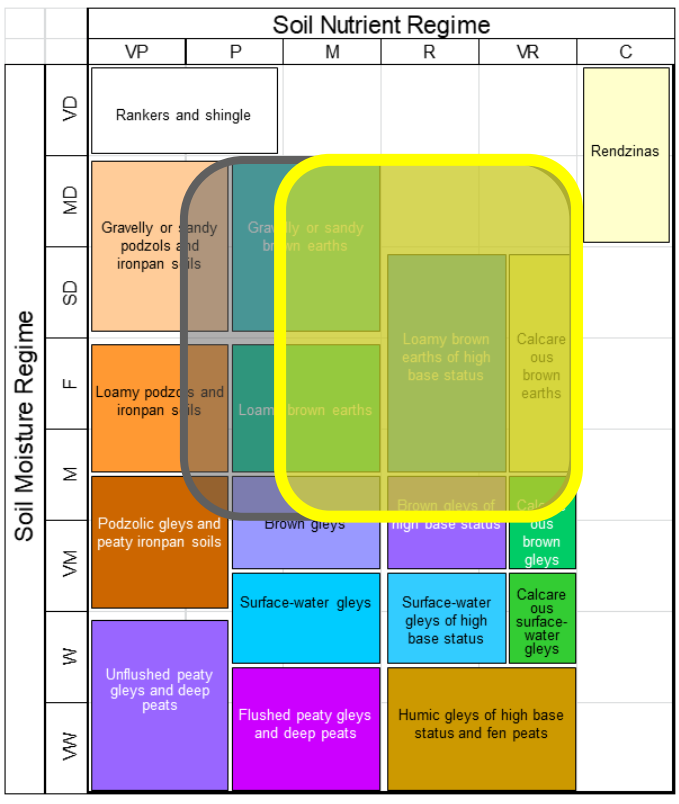
Natural regeneration is to be used for the majority of DF and minor species component.

2. Ecological suitability:

Represents no NVC type but provides niches for elements of W8, W9, W10, W11, and W15.

Appropriate on sheltered sites with well aerated soils of sandy to loamy texture, also suitable for droughty soils. Avoid exposed sites and frost hollows.





3. Management objectives:

Economic:	DF – joinery grade, target DBH > 80cm in 80 – 140yrs
	DF – sawlogs, target DBH > 60cm in 60 – 100yrs
Environmental and social:	Minor species elements increase habitat diversity and improve soil quality. Well-managed stands of DF, with a diverse age structure are attractive and popular for amenity and recreation. Maintains continuous forest cover.

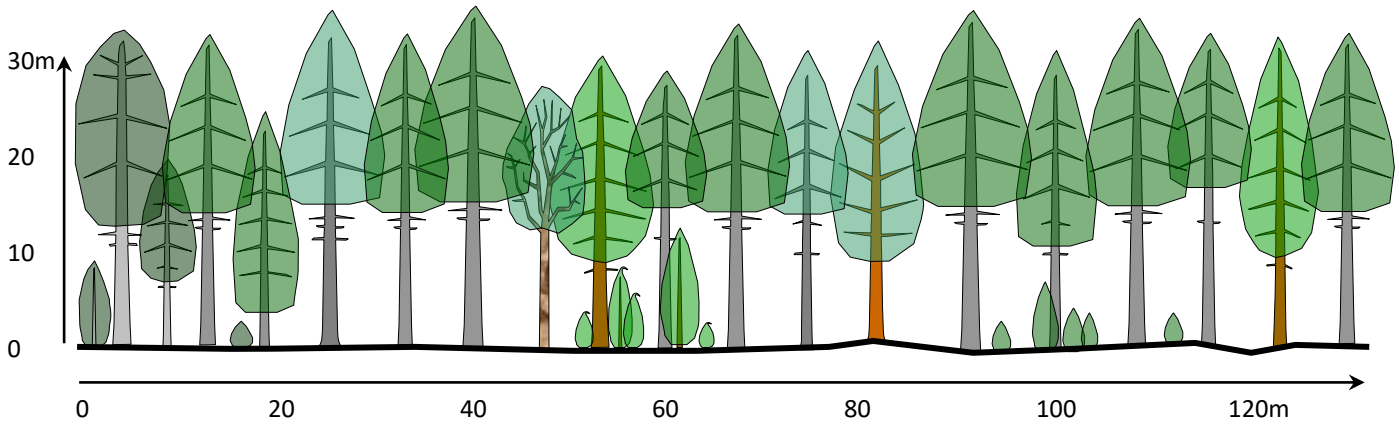
4. General management principles for the FDT

This FDT is for stands of DF growing on better sites compared to FDT 3.1.1 and where more structural diversity can be achieved by use of LIMA / CCF. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Stands originating from dense natural regeneration are likely to require respacing in order to develop individual tree stability. DF will respond well to thinning throughout its lifetime, however thinning must not be unduly delayed in order to achieve good tree stability and develop a complex stand structure. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. Final harvesting should be accompanied by establishment and differentiation of natural regeneration. DF can regenerate well under its own canopy on suitable sites. Target diameter harvesting and complex stand structures may be considered in sheltered conditions; simple structures and CCF management methods such as strip felling are preferable on more exposed sites.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Due to the wide natural range of DF careful choice of provenance is important.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 150 – 200 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha. • Pruning of (some) FC trees may be considered.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thin to develop a diverse stand structure and DBH range. • Plan for final harvesting when FC trees approach target DBH. • Decide on CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed CCF method. • Use target diameter harvesting / selective felling to create opportunities for natural regeneration and to diversify stand structure. • For simple structures refer to guidance in FDT 3.1.1. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 3.1.3 DF and shade tolerant conifers (XCST)

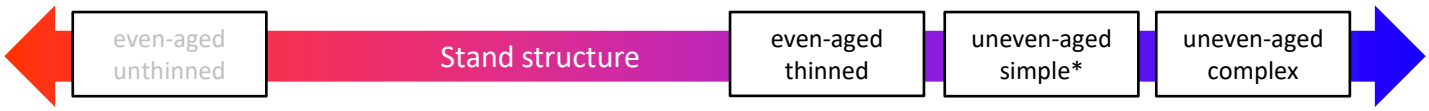


1. Structure and dynamics:

Mixed stand of DF and one or several XCST species, likely to include SS, WH, firs, WRC and others. Stands may be even-aged and single storied, or may develop into a complex structure. Mixture can be intimate, in small or large groups, or in patches. Supplemented by minor species of category A.

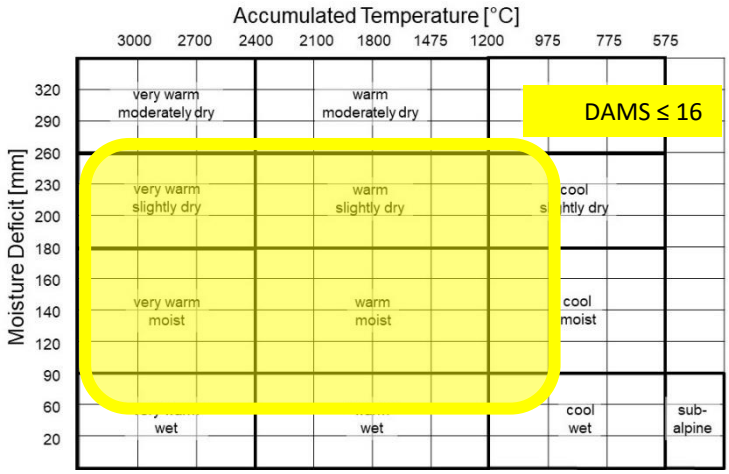
Species distribution: DF 60 – 80% XCST 20 – 40% minor species: < 10%

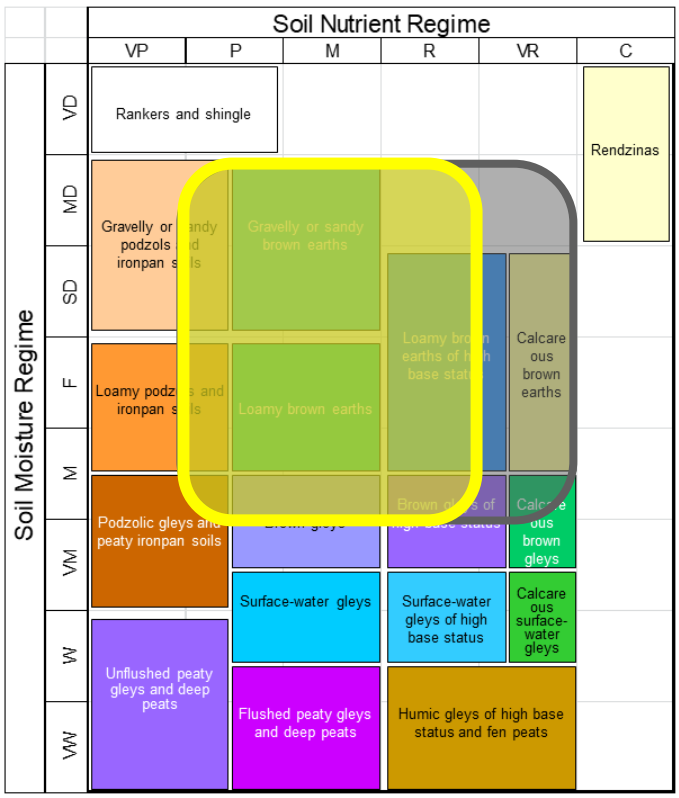
Management is likely to be by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of various upland and lowland types. Appropriate on sheltered sites with sandy to loamy soil texture, suitable for droughty soils. Avoid exposed sites and frost hollows.





3. Management objectives:

Economic:	DF – joinery grade, target DBH > 80cm in 80 – 140yrs
	DF – sawlogs, target DBH > 60cm in 60 – 100yrs
	XCST – optional, sawlogs, target DBH > 50cm in 80 – 140yrs
Environmental and social:	Increased habitat diversity, stand stability and maintenance of soil quality. The mixed-species and potentially diverse age structure of the stand is likely to be attractive and popular for amenity and recreation.

FDT 3.1.3 DF and shade tolerant conifers (XCST)

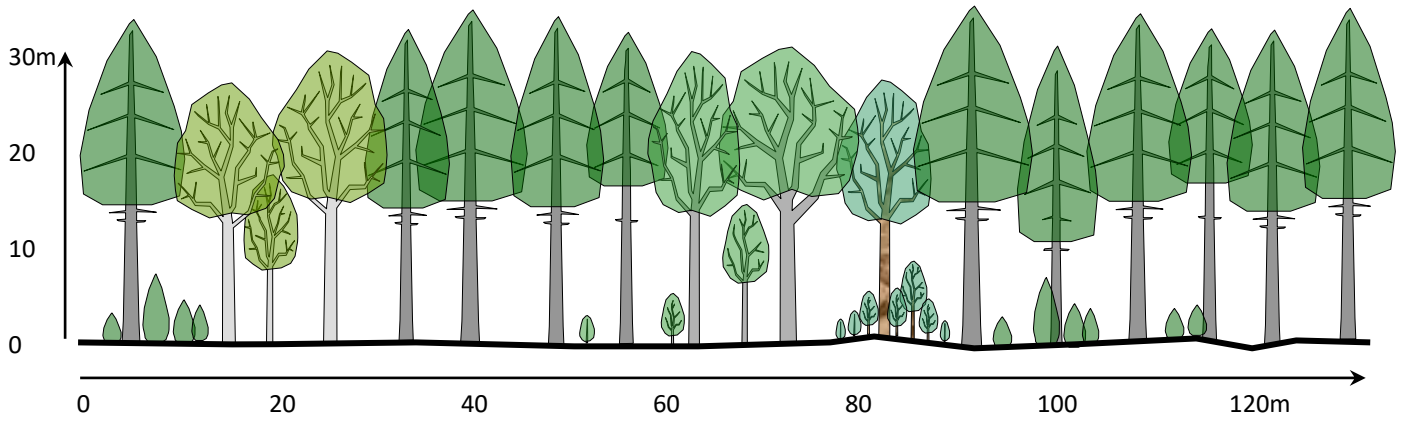
4. General management principles for the FDT

This FDT is 'DF with added diversity', the latter being provided by generally compatible (CS = 1 or 2) XCST, preferably managed using LIMA / CCF methods. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. More than one XCST species may be involved. All species should respond well to thinning throughout their lifetime, however thinning must not be unduly delayed in order to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration as many XCST may struggle to establish under open ground conditions. Complex CCF systems are a realistic option for this FDT.

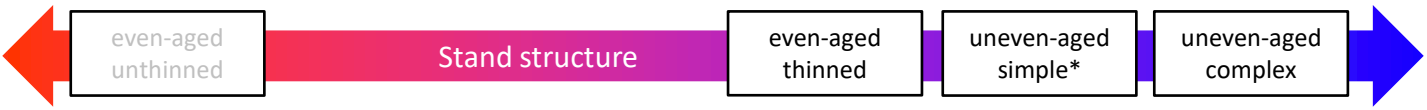
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Due to the wide natural range of DF careful choice of provenance is important. • XCST may be planted as beat-up or to supplement natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Steering of DF / XCST proportion in natural regeneration, promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 150 – 200 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / codominant trees with visible defects, coarse branching or poor shape. • Selection of ≤ 100 FC trees/ha (DF + XCST), consider pruning.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. • Focus on competition status of FC trees and target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. • In shelterwood scenarios, reduce BA to 30 – 40m^2/ha initially and then further once regeneration has established itself; lower BA values will benefit natural regeneration of DF, higher ones XCST. • For complex scenarios interventions should create an irregular canopy cover, encouraging regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

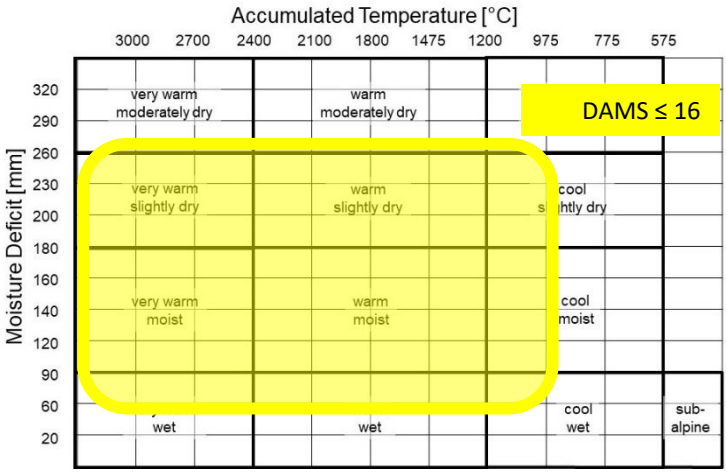
FDT 3.1.4 DF and long-lived broadleaves (XBLL)

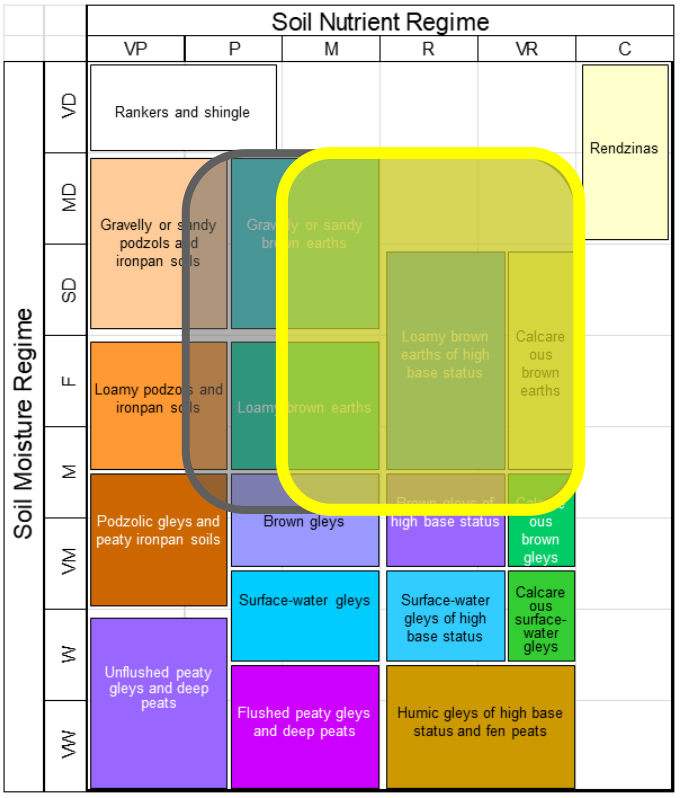


1. Structure and dynamics:
Single to multiple-storeyed DF stands interspersed with small to large groups of XBLL including BE, SY, SC, LI and others, plus category A minor species.
Species distribution: DF 70 – 90% XBLL 10 – 30% minor species: < 10%
Management is likely to be by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:
Represents no NVC type but contains many elements of various upland and lowland types. Appropriate on sheltered sites with sandy to loamy soil texture, suitable for droughty soils. Avoid exposed sites.





3. Management objectives:

Economic:	DF – joinery grade, target DBH > 80cm in 80 – 140yrs DF – sawlogs, target DBH > 60cm in 60 – 100yrs XBLL – optional
Environmental and social:	Uneven-aged forest structure provides habitats for a range of species and lends itself to low-impact management. Structural and species diversity maintain soil fertility better and improve stability with regard to risk factors compared to pure DF stands. Attractive to visitors because of its diverse structure, broadleaved component and autumn colours.

FDT 3.1.4 DF and long-lived broadleaves (XBLL)

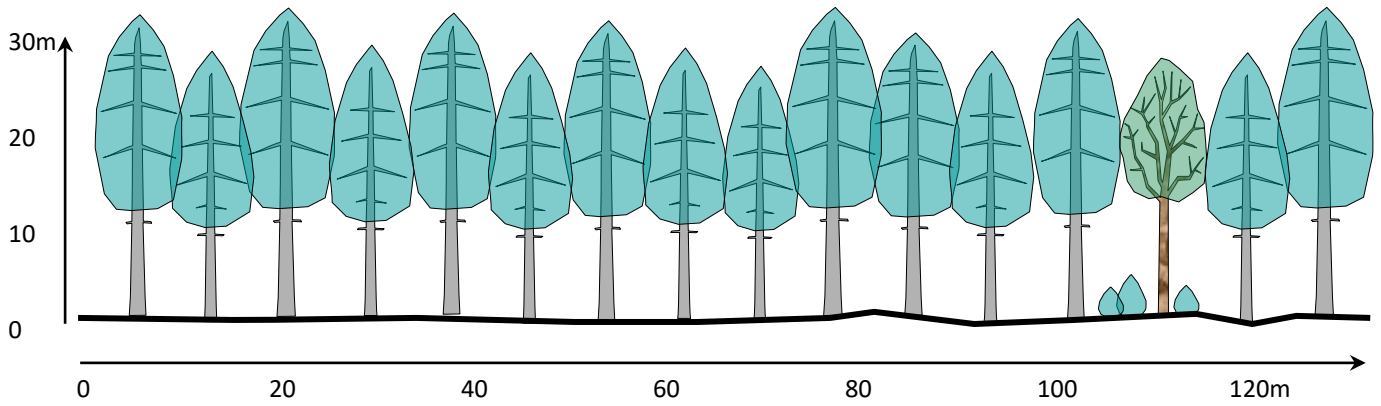
4. General management principles for the FDT

Compatibility of the FDT components varies with XBLL species (CS = 1 for SY, CS = 4 for SC). The fast growth rate and taller final height of DF should therefore be compensated by the positioning of XBLL in groups, which will also benefit timber quality. Management of young stands must aim to develop vigour (XBLL) and stability (DF) of individual trees. Stands originating from dense natural regeneration are likely to require respacing in order to steer species composition and develop good tree stability. DF will respond well to thinning throughout its lifetime but in order to maintain good tree stability thinning must not be unduly delayed and should start at around 10 – 12m top height, generally as crown thinning. Thinning of XBLL must aim to develop and maintain large crowns early on, aiming to produce vigorous and stable trees which are able to maintain their position within a DF dominated canopy. LIMA / CCF methods are the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Due to the wide natural range of DF careful choice of provenance is important. • XBLL should be planted in robust groups or rows depending on the compatibility of XBLL species and envisaged production targets.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing of DF as in FDT 3.1.3. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Negative selective respacing of dense XBLL regeneration. • Release 150 – 200 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of ≤ 100 FC trees/ha (DF + XBLL), consider pruning.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m. Monitor competition between DF and XBLL and adjust thinning accordingly. • Thinning in pockets of XBLL suitable for timber production should only start when FC trees have developed a sufficiently long clean bole. • Focus on competition status of FC trees and target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • In shelterwood scenarios, reduce BA to 25 – 40m^2/ha initially (depending on shade tolerance of the XBLL) and then further once regeneration has established. Light demanding XBLL may require regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 3.2.1 Pacific North-West American (PNWA) firs

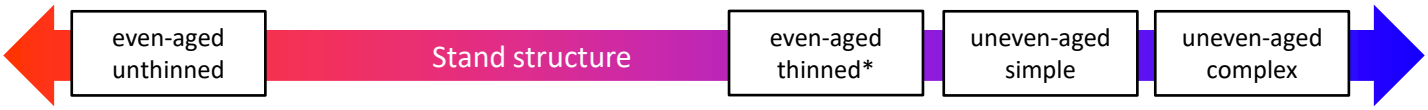


1. Structure and dynamics:

Single species stands of NF / GF / PSF with category A minor species, including remnants of nurse crops such as LP / SP. They provide an alternative to similar FDTs with SS, NS or DF as the primary species.

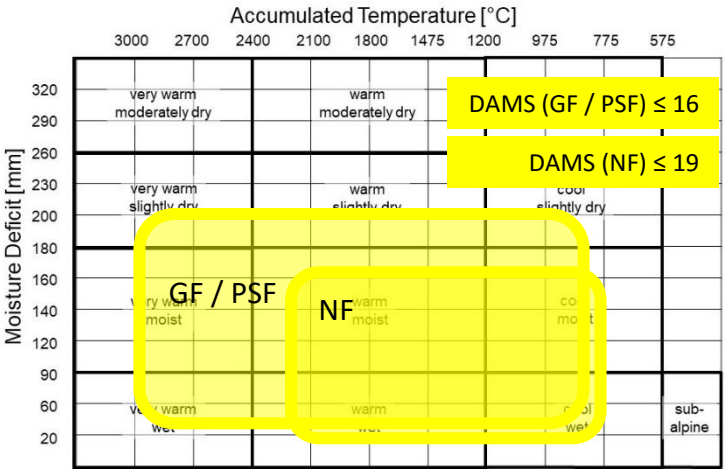
Species distribution: PNWA firs 90 – 100% minor species: < 10%

Stands may be managed under clearfell-and-restock regimes but LIMA / CCF methods including natural regeneration should be used wherever practical.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of W10, W11, W15 and W16. Site requirements vary slightly between species but in general this FDT is appropriate for deeper soils of loamy texture and at least poor fertility. Heavy clay loams, calcareous, and waterlogged soils are best avoided.



3. Management objectives:

Economic: GF / PSF – sawlogs / pulp / chip, target DBH > 40cm in 50 – 80yrs
NF – sawlogs / pulp / chip, target DBH > 35cm in 50 – 80yrs
Timber quality is reportedly poor but may be improved on sites of lower GYC and in CCF scenarios. Young stands can be used for Christmas tree and foliage production.

Environmental and social: Mature stands are attractive and popular for amenity and recreation. Minor species elements increase habitat diversity and improve soil quality.

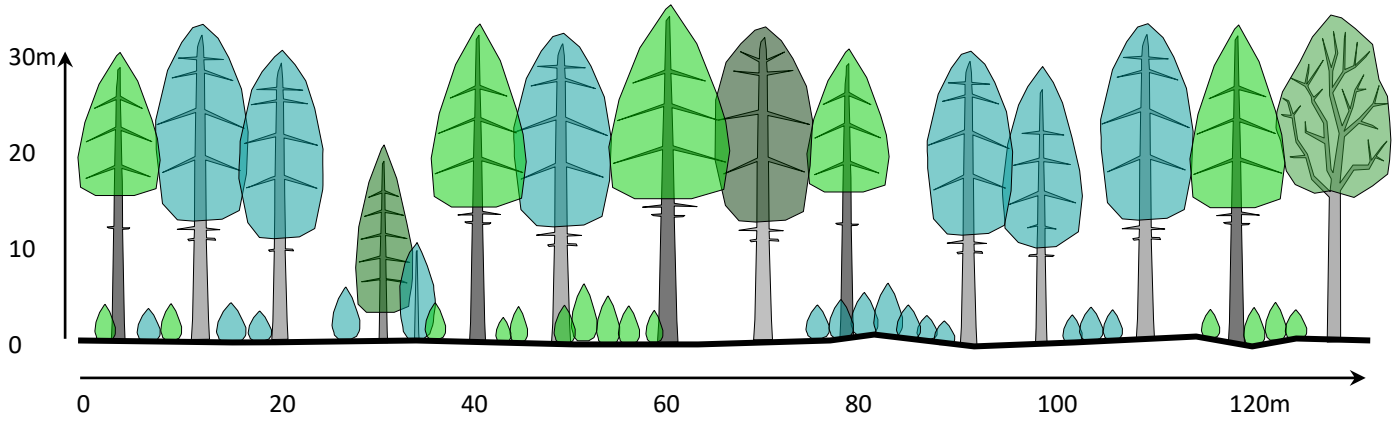
4. General management principles for the FDT

This FDT should be used where clearfell-and-restock scenarios with PNWA firs as an alternative to SS, NS or DF are envisaged. No-thinning scenarios are possible but will limit options for final harvesting and restocking. PNWA firs are not as shade tolerant as ESF and therefore allow stands to be established in open ground conditions as well as under canopy. Height growth is very slow to begin with but speeds up later, resulting in highly productive stands on suitable sites. All species are highly palatable to mammals. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Stands originating from dense natural regeneration are likely to require respacing. PNWA firs will respond well to thinning throughout their lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Crown thinning should be used as long as necessary to develop good individual tree stability, however the thinning type may eventually shift towards low thinning, particularly in more exposed areas. Natural regeneration is usually prolific and therefore LIMA / CCF methods should be considered for final harvesting / restocking on suitable sites. During the rotation there may be opportunities for species diversification and, if taken, the FDT may need to be reviewed.

5. Timeline

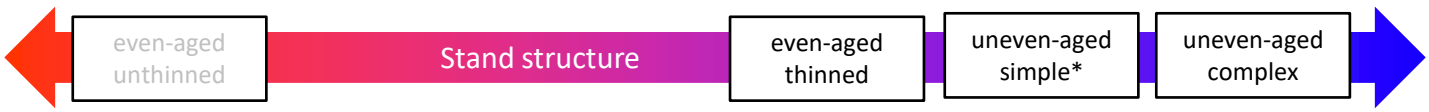
stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. Consider options for foliage harvesting or Christmas trees. • Clearing of any damage caused by felling / extraction of overstorey trees. • Promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (optional).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when dominant / FC trees approach target DBH. • Decide on LIMA / CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. • In shelterwood scenarios, reduce BA to 25 (NF) – 35 (GF / PSF) m^2/ha initially, and then further once regeneration has established. • Design strip systems with regard to prevailing wind direction and climatic requirements of natural regeneration; keep strip width < 50m. • Monitor light level, seedbed conditions, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 3.2.2 Pacific North-West American (PNWA) firs



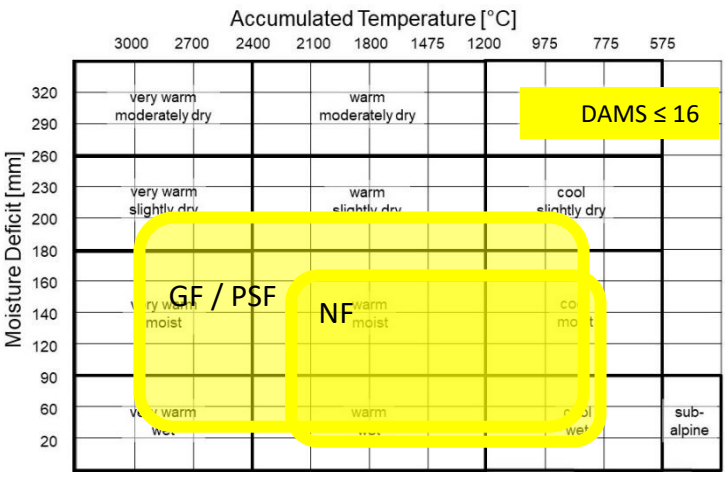
1. Structure and dynamics:

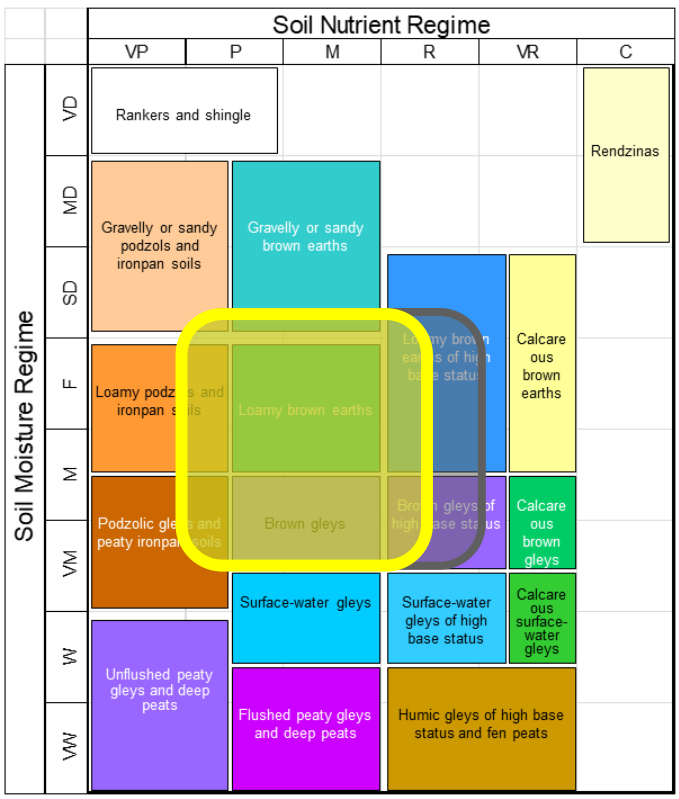
Single to multiple-storeyed mixed PNWA fir stand with category A minor species which mostly occupy the understorey, suitable microsites and areas of difficult access. Mixture type can be intimate or in groups.
Species distribution: PNWA firs 80 – 90% minor species: 10 – 20%
Stands should be managed under LIMA or CCF regimes, aiming to create a complex stand structure.
Natural regeneration is to be used for all species if possible but supplementary planting may be required to maintain mixture proportions.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of W10, W11, W15 and W16. Site requirements similar to those of FDT 3.2.1 but better suited to more fertile and variable soil conditions due to species composition. Avoid very exposed sites, calcareous soils, and waterlogged soils of clayey texture.





3. Management objectives:

Economic:	GF / PSF – sawlogs / pulp / chip, target DBH > 50cm in 50 – 90yrs NF – sawlogs / pulp / chip, target DBH > 40cm in 60 – 100yrs
Environmental and social:	Attractive stands of mixed PNWA firs, with high amenity and recreation value. Minor species elements increase habitat diversity and improve soil quality. Maintains continuous forest cover.

FDT 3.2.2 Pacific North-West American (PNWA) firs

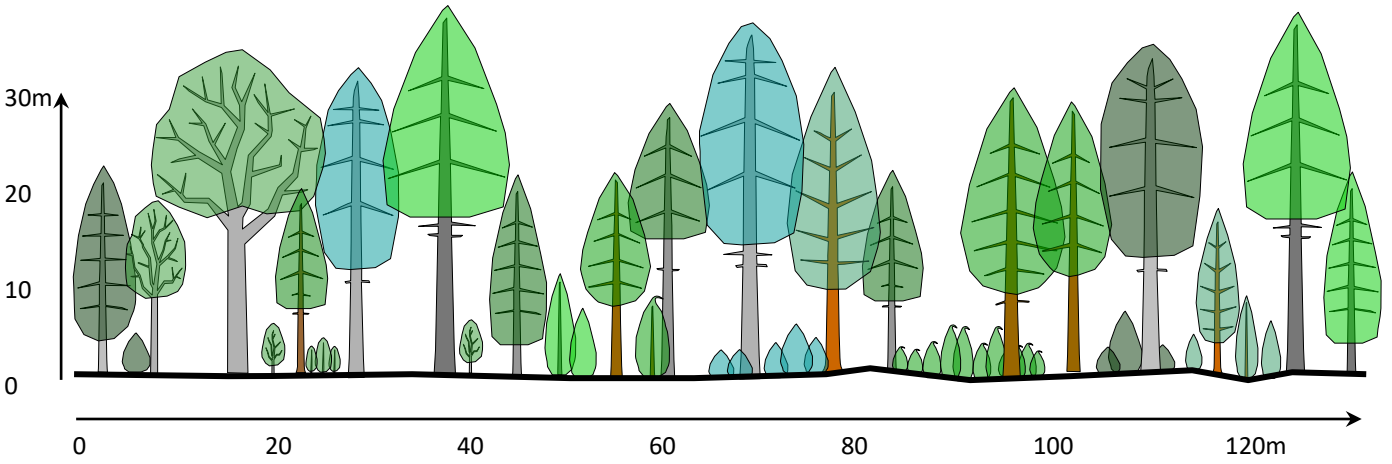
4. General management principles for the FDT

Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later. Stands originating from dense natural regeneration may require respacing in order to achieve the desired species composition and to develop individual tree stability. PNWA firs will respond well to thinning throughout their lifetime, however thinning must not be unduly delayed to achieve good tree stability. Crown thinning should be used as long as necessary to develop good individual tree quality and stability. PNWA firs occur in natural mixtures within their native range but there are differences in growth rate and light demand, meaning that less competitive species such as NF may have to be favoured in thinning interventions. Final harvesting should be accompanied by establishment and differentiation of natural regeneration. PNWA firs can regenerate well under canopy Target diameter harvesting and complex stand structures may be considered on sheltered sites; simple structures and CCF methods such as strip shelterwood are preferable on more exposed ones.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. NF as the least competitive and most light demanding species will benefit from establishment in groups and under small canopy gaps.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Management of species composition in natural regeneration scenarios, promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 200 – 300 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha across all species.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thinning type may gradually change to low. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. • In shelterwood scenarios, reduce BA to 25 – 35m^2/ha initially and then further once regeneration has established itself; higher BA values will benefit natural regeneration of GF and PSF, lower ones NF. • For complex scenarios interventions should create an irregular canopy cover, encouraging uneven-aged regeneration in groups. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

FDT 3.2.3 PNWA firs and shade tolerant conifers (XCST)

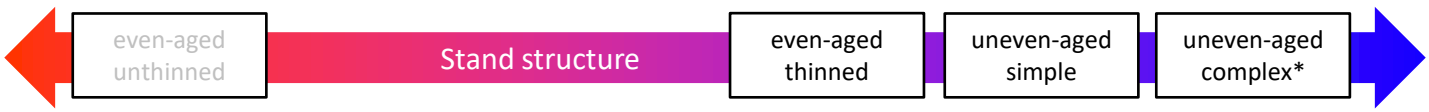


1. Structure and dynamics:

Mixed stand of PNWA firs (NF, GF, PSF) and one or several XCST species, likely to include NS, WH, DF, WRC and others. Stands may initially be single storied but are likely to develop a complex structure. Mixture can be intimate, in small or large groups. Supplemented by category A minor species, preferably including shade tolerant XBLL (BE) mainly found in the middle and understorey, occasionally in the overstorey.

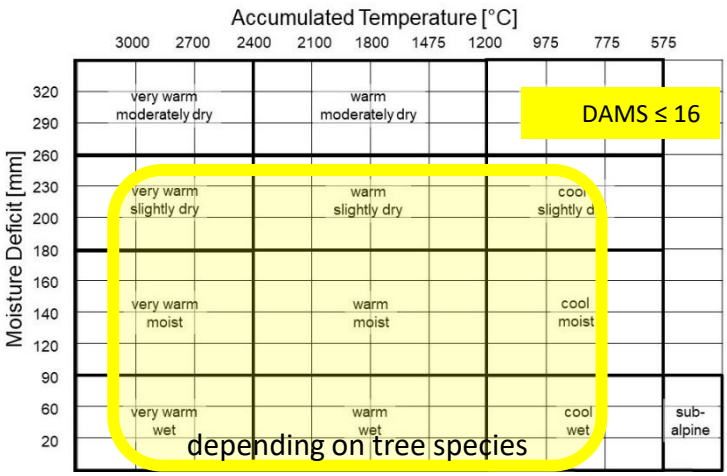
Species distribution: PNWA firs 60 – 80% XCST 20 – 40% minor species: < 20%

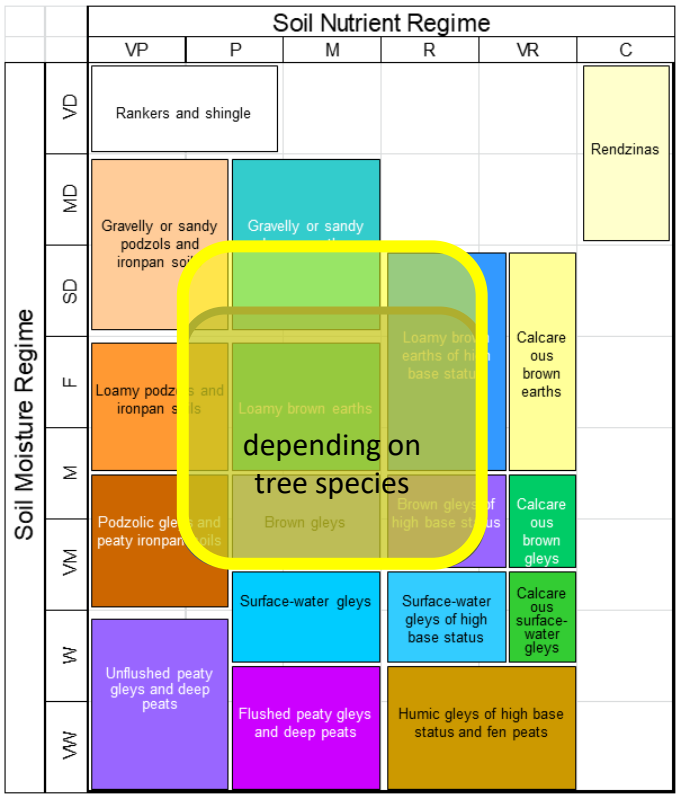
Management is likely to be by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:

Represents no NVC type but provides niches for elements of various upland and lowland types (e.g. W16 or W8). Appropriate on deep soils with loamy texture and variable fertility according to species composition. Requires good water supply but waterlogged soils are to be avoided. NF is preferable over other PNWA firs on more exposed sites.





3. Management objectives:

Economic:	GF / NF / PSF – sawlogs / pulp / chip, target DBH > 50cm in 60 – 140yrs XCST – optional, (quality) sawlogs, target DBH > 60cm in 80 – 140yrs
Environmental and social:	Increased habitat diversity, stand stability and maintenance of soil quality. Mixed stands with diverse structure and presence of large trees are likely to be attractive and popular for amenity and recreation.

FDT 3.2.3 PNWA firs and shade tolerant conifers (XCST)

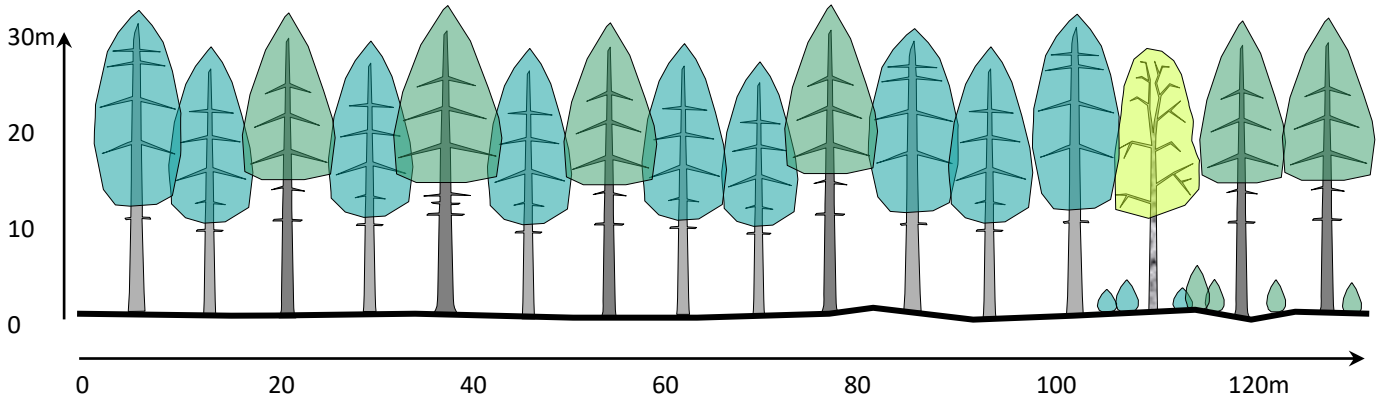
4. General management principles for the FDT

This FDT is 'PNWA firs with added diversity', the latter being provided by generally compatible (CS = 1 or 2) XCST, preferably managed using LIMA / CCF methods. The FDT mimics native North-West American woodlands including firs, WH, WRC, DF, RSQ mixed with European XCST such as ESF and NS. BE is the main broadleaved species likely to be a significant component within the minor species and should be promoted. Management of young stands must aim to develop vigour and stability of individual trees in order to allow flexible management of stand structure later on. Stands originating from dense natural regeneration may require respacing in order to steer species composition and develop good tree stability. All species should respond well to thinning throughout their lifetime, however thinning must not be unduly delayed to achieve good tree stability. Thinning regimes should generally start at around 10 – 12m top height and use crown thinning as long as necessary to develop good individual tree quality and stability. LIMA / CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration as most species involved may struggle to establish under open ground conditions. Complex CCF systems are a realistic option for this FDT.

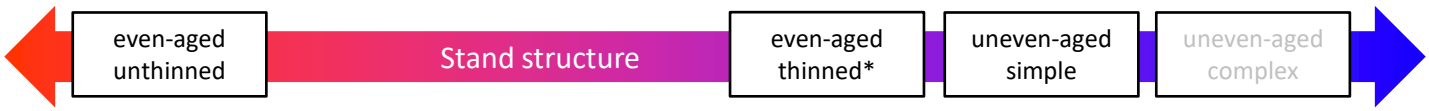
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. Less competitive species are best established in groups of their own.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Respacing to steer species composition and to promote minor species (BE) as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 200 – 300 FC tree candidates/ha in areas of difficult access or high wind hazard if respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 100 – 150 FC trees/ha across all species.
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, otherwise thin to develop a diverse stand structure and wide DBH range. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Use target diameter harvesting / selective felling to create opportunities for natural regeneration and to diversify stand structure. • For simple structures refer to guidance in FDT 3.2.2. • Monitor light level, seedbed conditions, occurrence and growth rate of regeneration, supplement by planting if necessary.

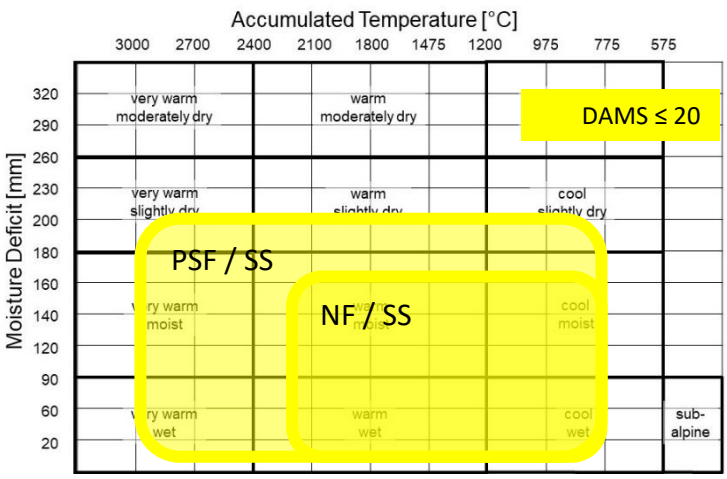
FDT 3.2.4 Pacific North-West American (PNWA) firs with SS

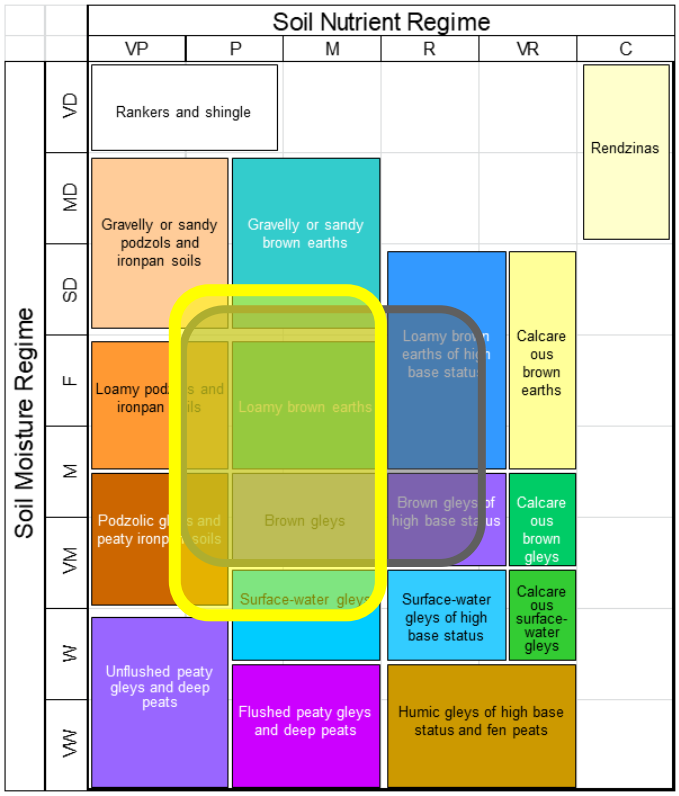


1. Structure and dynamics:
Mixed stand of NF and / or PSF with SS, usually even-aged and single storied and supplemented by minor species of category A. Mixture type can range from intimate to large groups.
Species distribution: NF / PSF 60 –80% SS 20 – 40% minor species: < 10%
Management is likely to be by clearfelling and restocking, or by LIMA / CCF, making use of natural regeneration wherever possible.



2. Ecological suitability:
Represents no NVC type but provides niches for elements of W4, W17 and W18. Predominantly, but not exclusively, on exposed sites of poor fertility where SS is expected to grow below GYC 16 and options for CCF are limited. Not suitable for severely waterlogged soils, otherwise a good alternative to pure SS stands.





3. Management objectives:

Economic (GYC < 16):	NF / PSF – sawlogs / pulp / chip, target DBH > 35cm in 50 – 80yrs SS – sawlogs / pulp / chip, target DBH > 40cm in 50 – 80yrs
Environmental and social:	The mixed stand structure increases habitat diversity and improves landscape value as well as stability and resilience with regard to risk factors over pure SS stands. In many upland areas these stands fulfil important roles in regulating water flow in catchment areas.

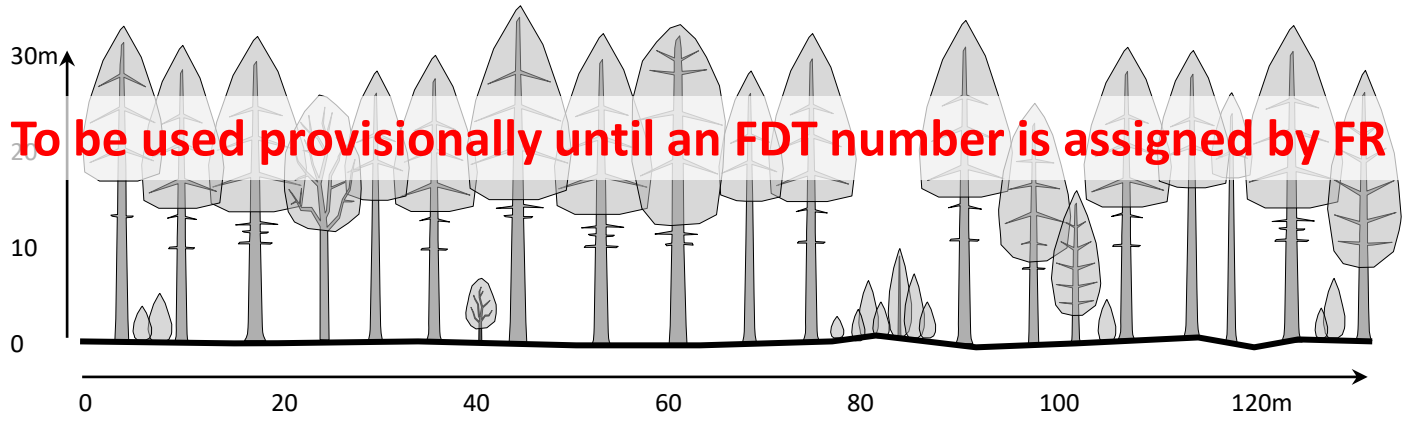
4. General management principles for the FDT

This FDT has been designed as an alternative to conventional SS stands on more exposed sites, with added diversity and improved stability due to the rooting habits of PNWA firs. NF, PSF and SS differ slightly in their growth rates and light demand but are well suited to grow in mixtures (CS = 2). Management of young stands should aim to secure PNWA firs if there is profuse natural regeneration of SS; this may require (repeated) respacing. Developing good tree stability is also important if the stand is to be thinned. A no thinning approach is possible but will limit management options and achievable target DBH, in extreme cases it may even drive the FDT toward 1.1.5. All species will respond well to thinning throughout their lifetime but in order to maintain good tree stability thinning must not be unduly delayed. Thinning should start at around 10 – 12m top height, generally as crown thinning. Thinning at later stages should aim to maintain an even canopy cover; with thinning type changing to low. LIMA / simple CCF methods should be the preferable option for final harvesting / restocking on sites conducive to natural regeneration.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 2000 – 3000 trees/ha or natural regeneration. • Due to their slower initial growth rates, NF and PSF should be planted in groups or mixtures of at least 3 rows.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access, along exposed edges and on sites of high wind damage risk reduce N to 800 – 1000 trees/ha. • Clearing of any damage caused by felling / extraction of overstorey trees. • Steering of PNWA firs / SS proportion in natural regeneration, promotion of minor species as required.
Thicket stage	3 – 10	• Generally no interventions, except for: • Release 300 – 400 FC tree candidates/ha in areas of difficult access or high wind hazard if the stand is to be thinned and respacing in the previous stage has been missed.
Pole stage	10 – 12	• First selective thinning (crown thinning), mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. • Selection of 150 – 250 FC trees/ha (optional, PNWA firs + SS).
Pole to small timber stage	12 – 20	• Continue crown thinning at height growth intervals of 3m, focussing on the competition status of FC trees.
Timber stage		• Monitor species composition, crown length, h/d ratio (stability indicators), BA and canopy cover (competition indicators) and thin accordingly. • Apply crown thinning as long as necessary for benefits of FC trees and stand stability, otherwise gradually change thinning type to low. • Plan for final harvesting when dominant / FC trees approach target DBH. • Assess potential for natural regeneration and improve conditions if necessary, review suitability of FDT in the light of species composition within regeneration, and consider LIMA / CCF options for final harvesting.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

FDT 4.8.1 Other shade tolerant conifers (XCST)



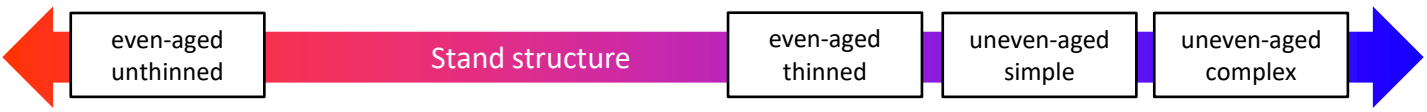
To be used provisionally until an FDT number is assigned by FR

1. Structure and dynamics:

This is a broad FDT covering any other shade tolerant conifer species, including multiple species mixtures and emerging species. Stands may be even-aged and single storied to begin with but are likely to develop a more complex structure later. Mixture type, if applicable, may range from intimate to patches. Minor species of category A, recruiting from natural infill depending on site condition.

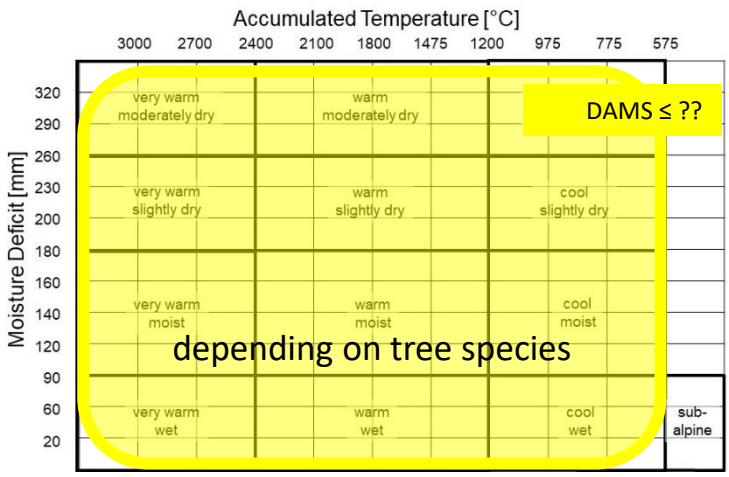
Species distribution: XCST 80 – 100% minor species: < 20%

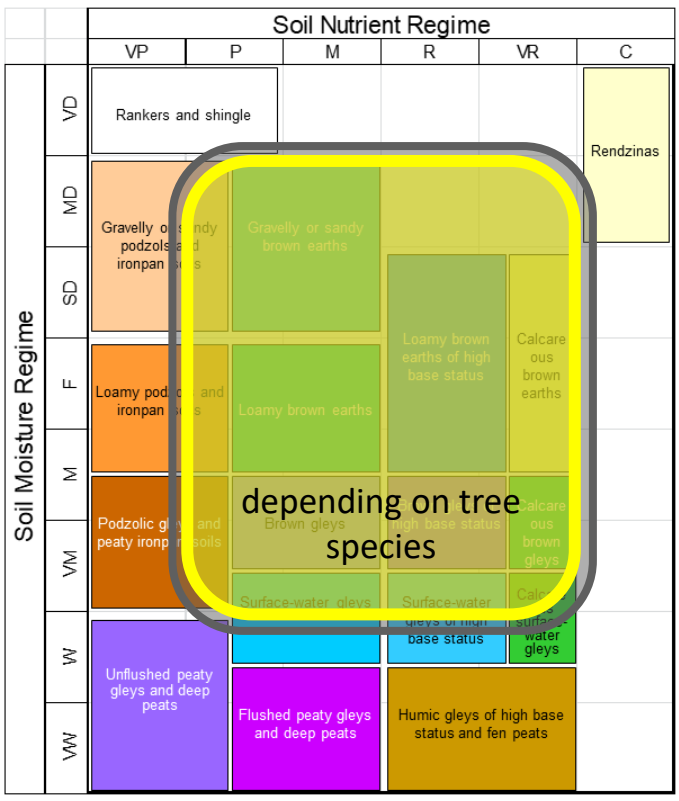
Stands may be managed by clear felling and restocking, LIMA or CCF. Natural regeneration of the major species should be used wherever possible.



2. Ecological suitability:

This broad FDT should be carefully matched to site type to ensure that the soil texture and climatic conditions are appropriate for the species, and that the FDT can deliver the management objectives for the site.





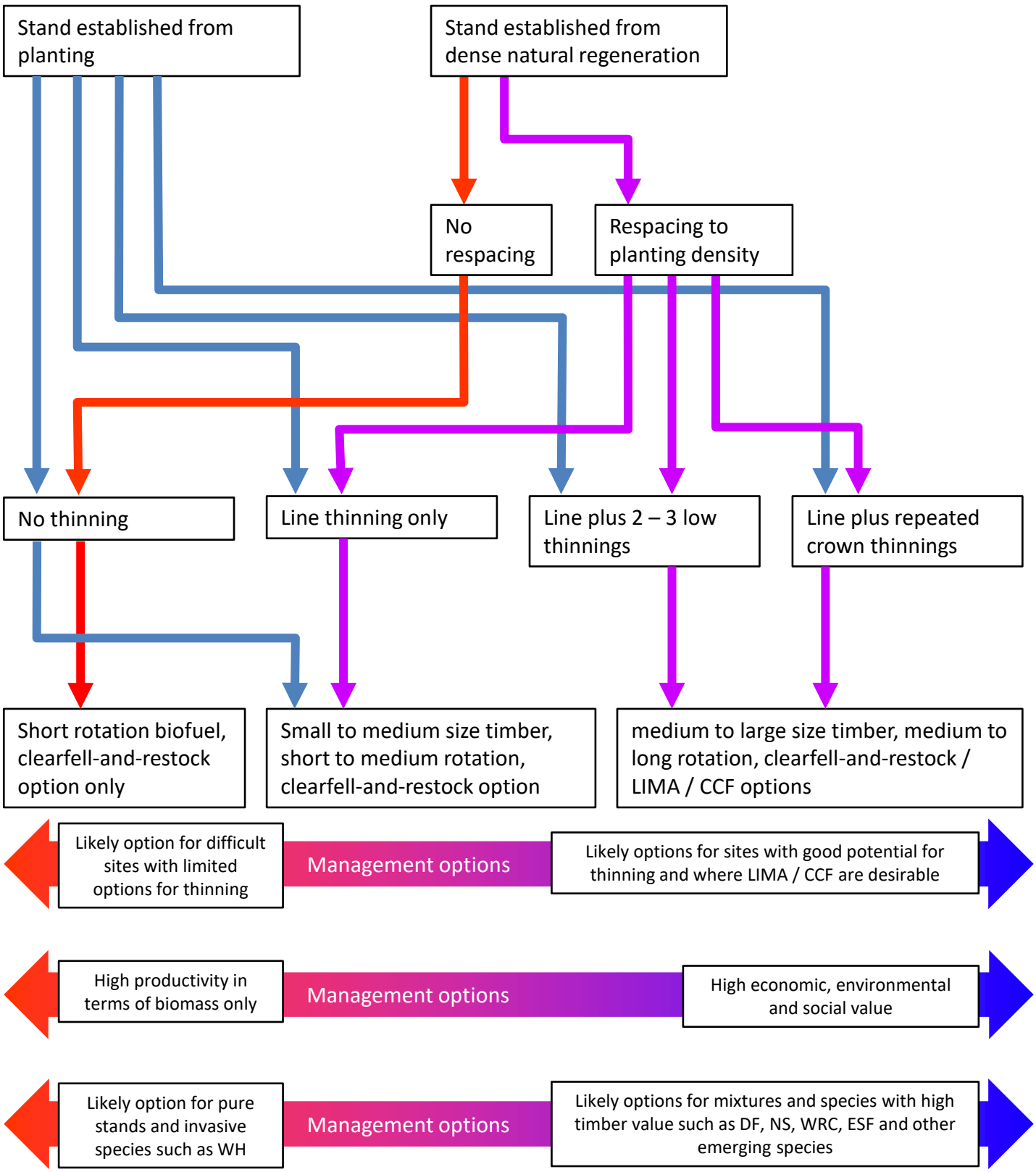
3. Management objectives:

Economic:	XCST – optional, depending on tree species
Environmental and social:	Maintaining or improving the physical and chemical soil properties is paramount. Other environmental and social management objectives will be driven by local context. Likely to produce an attractive stand with a diverse age structure which is popular for amenity and recreation.

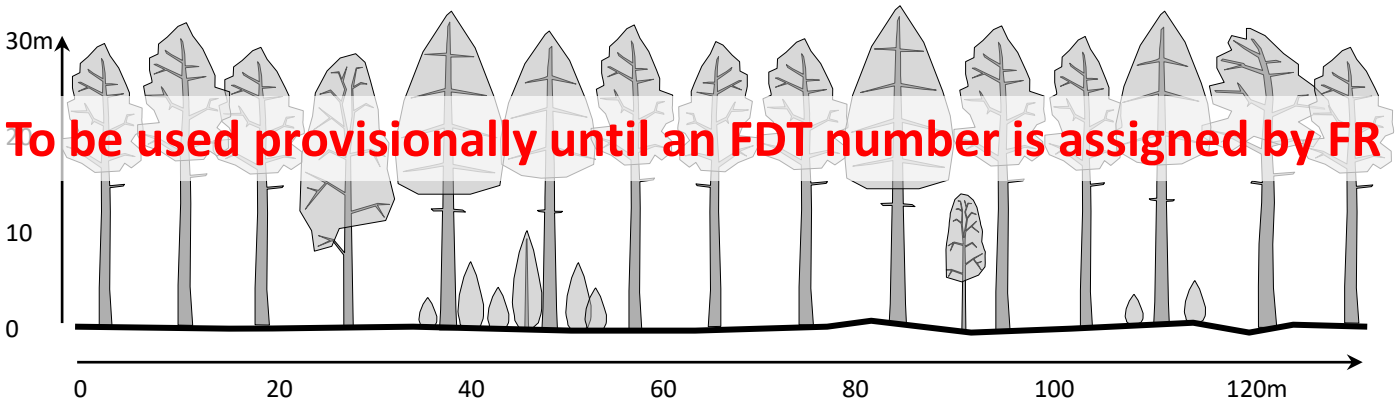
4. General management principles for the FDT

This FDT encompasses a wide range of options, including scenarios with limited or no thinning interventions, short rotation biomass production and scenarios which may result in LIMA or CCF management. A general overview is given below; detailed guidance on management may be derived from other FDTs as appropriate.

5. Overview



FDT 4.9.1 Other light demanding conifers (XCLD)



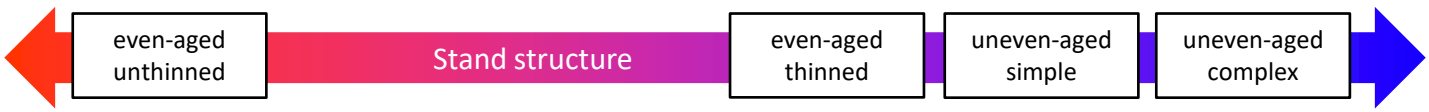
To be used provisionally until an FDT number is assigned by FR

1. Structure and dynamics:

This is a broad FDT covering any other light demanding conifer species, including mixtures and emerging species. Stands are likely to be even-aged and single storied to begin with but could develop a more complex structure later. Mixture type, if applicable, may range from intimate to patches. Minor species of category B, recruiting from natural infill depending on site condition.

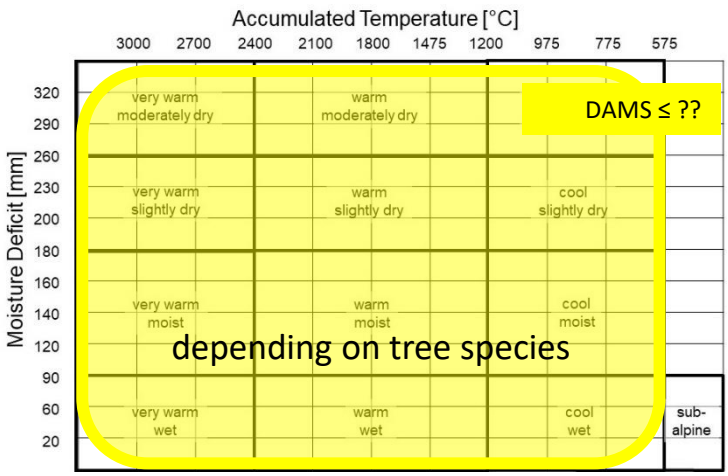
Species distribution: XCLD 80 – 100% minor species: < 20%

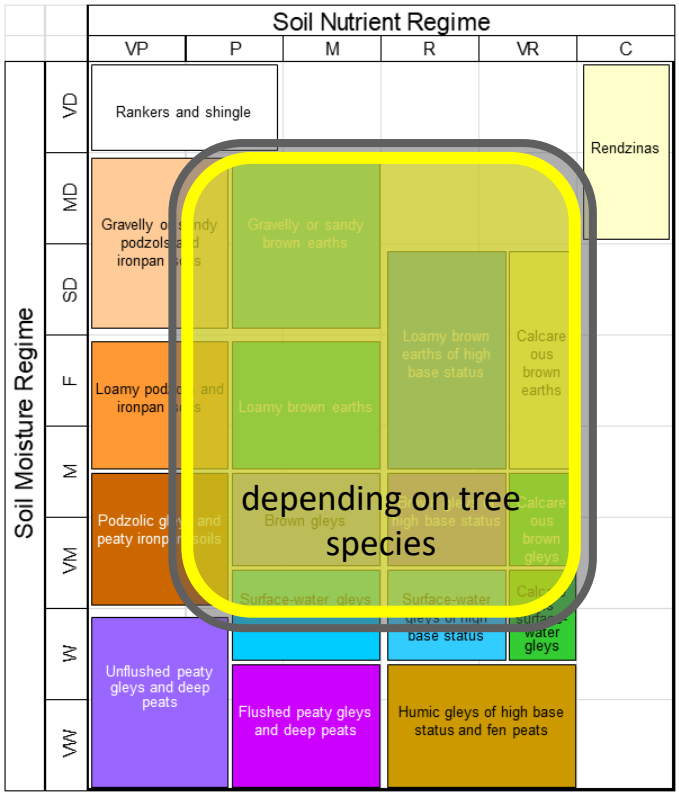
Stands may be managed by clear felling and restocking, LIMA or CCF. Natural regeneration of the major species should be used wherever possible.



2. Ecological suitability:

This broad FDT should be carefully matched to site type to ensure that the soil texture and climatic conditions are appropriate for the species, and that the FDT can deliver the management objectives for the site.





3. Management objectives:

Economic: XCLD – optional, depending on tree species

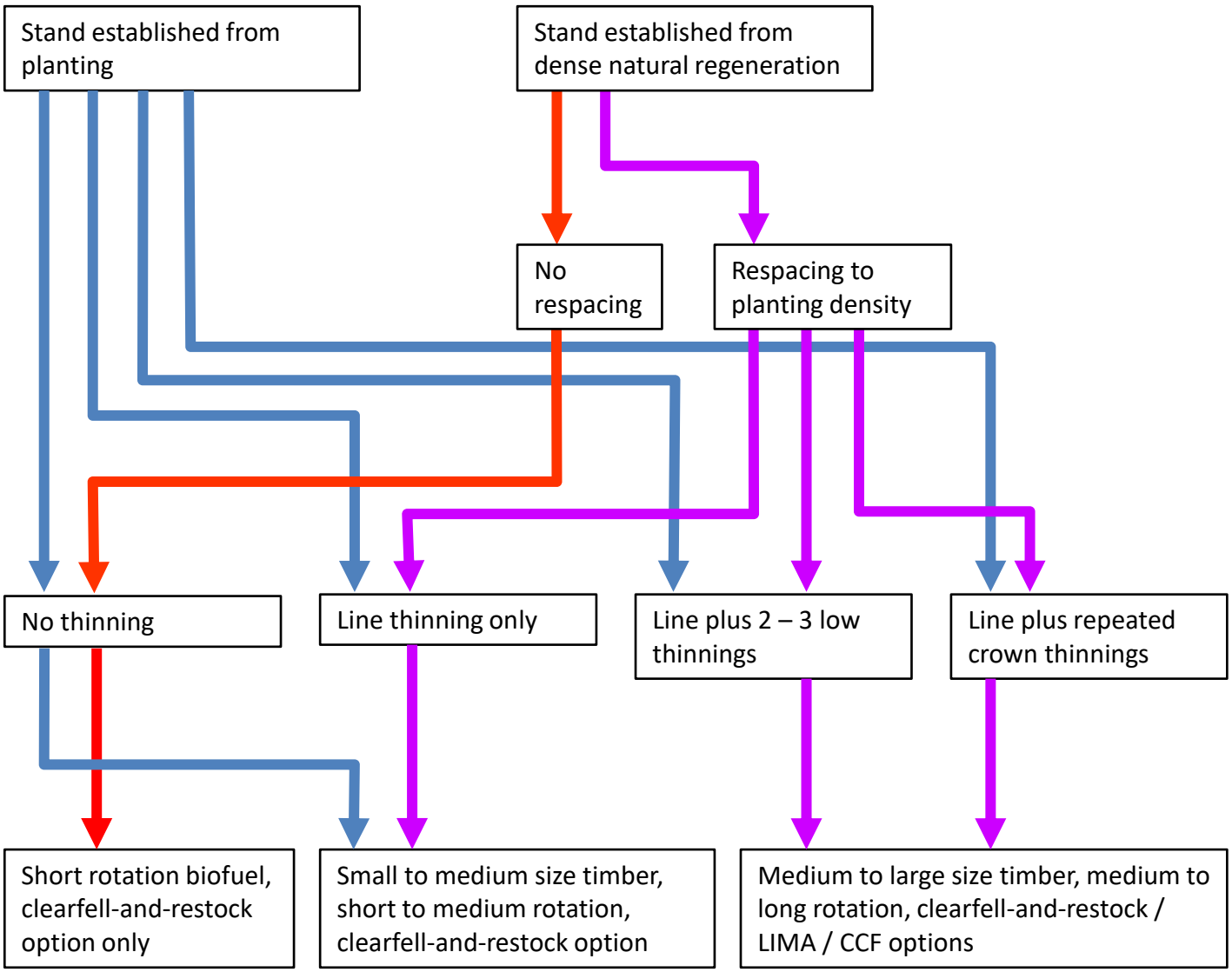
Environmental and social: Maintaining or improving the physical and chemical soil properties is paramount. Other environmental and social management objectives will be driven by local context.

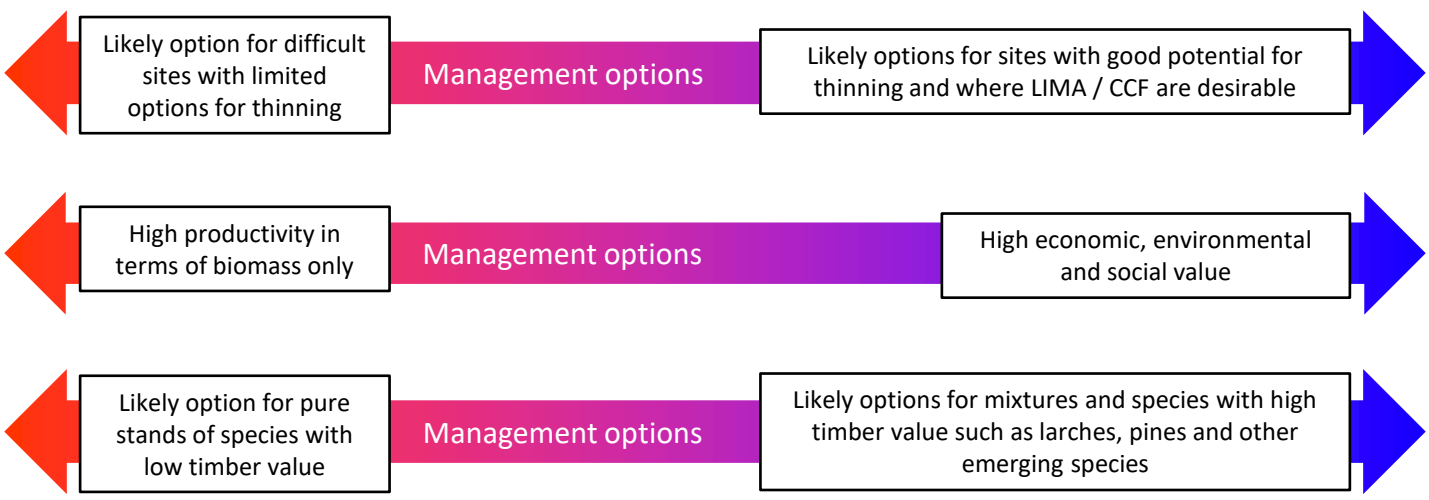
FDT 4.9.1 Other light demanding conifers (XCLD)

4. General management principles for the FDT

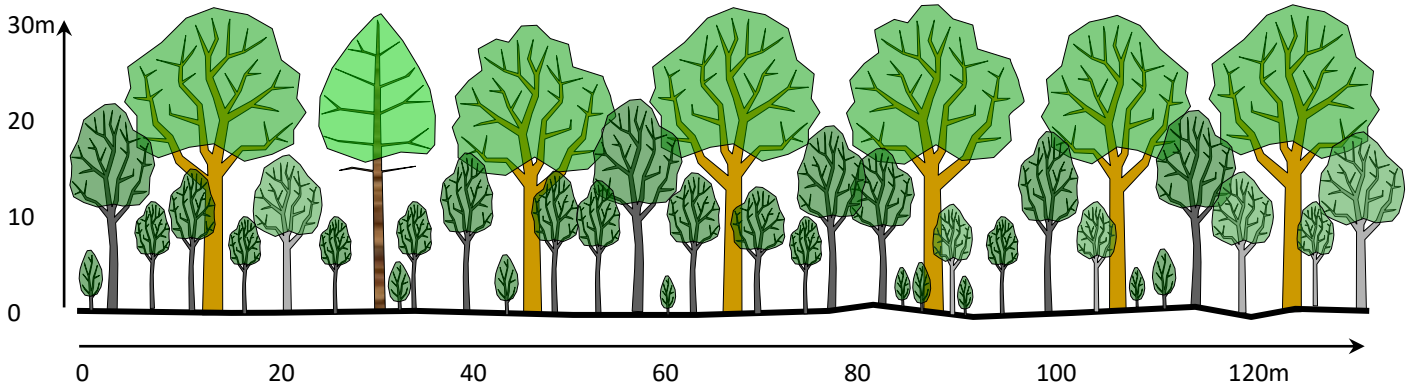
This FDT encompasses a wide range of options, including scenarios with limited or no thinning interventions, short rotation biomass production and scenarios which may result in LIMA or CCF management. A general overview is given below; detailed guidance on management may be derived from other FDTs as appropriate.

5. Overview

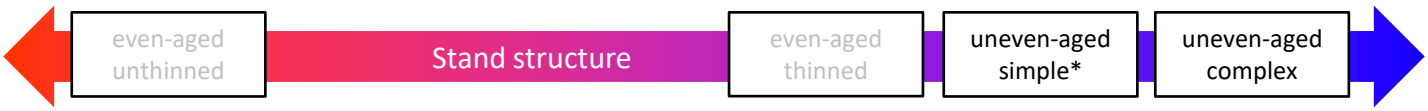




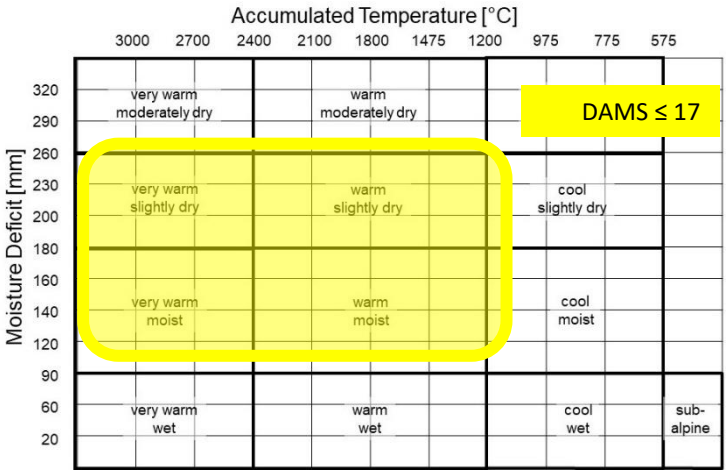
FDT 5.1.1 POK and HBM

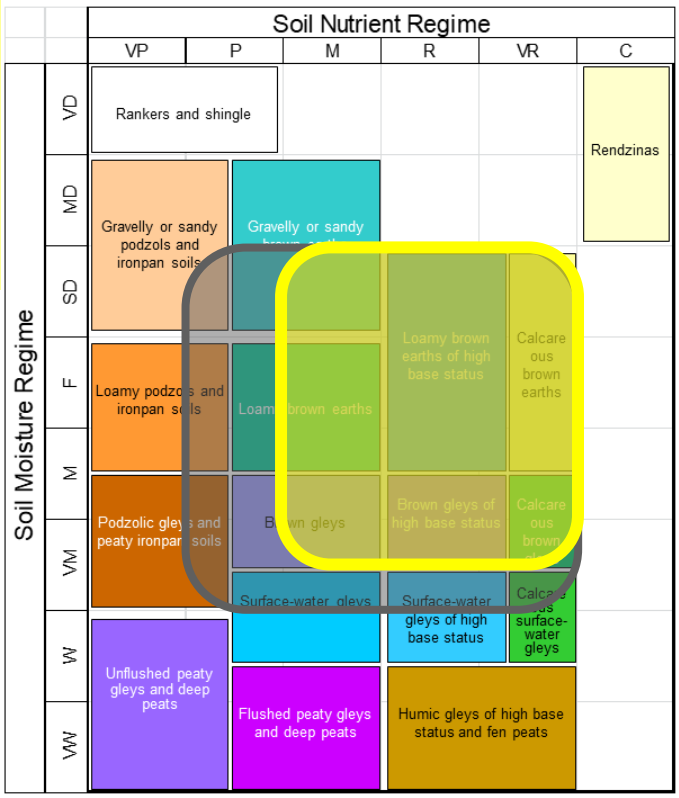


1. Structure and dynamics:
Two- or multi-storeyed stand of dominating POK with admixed HBM in middle and understorey. HBM in single tree to small group mixture. Minor species of category C may include BE, SLI, BI, ASP, ROW, AR, WCH, EM and others.
Species distribution: POK 70 – 90% HBM 10 – 30% minor species: < 10%
Likely originating from POK stands underplanted with HBM, minor species from infill. Stands should be managed under LIMA / CCF regimes with best possible use of natural regeneration of POK.



2. Ecological suitability:
Resembles NVC types W8 and W10 of the lowland climatic zones. Suitable for moister soils of good nutrient supply (heavier clay loams) where POK grows at its full potential (GYC > 6) and is capable of producing high quality timber. A good option for conversion of pure POK stands requiring diversification by enrichment planting.





3. Management objectives:

Economic (POK GYC > 6):	POK – veneer / planking grade, target DBH > 70cm in 120 – 160yrs
	POK – sawlogs, target DBH > 60cm in 100 – 140yrs
	HBM – sawlogs, target DBH > 40cm in 80 – 140yrs
Environmental and social:	Diverse woodland of natural appearance and high conservation value. HBM element serves to improve timber quality and control ground vegetation. Attractive to visitors because of its diverse structure and tree size.

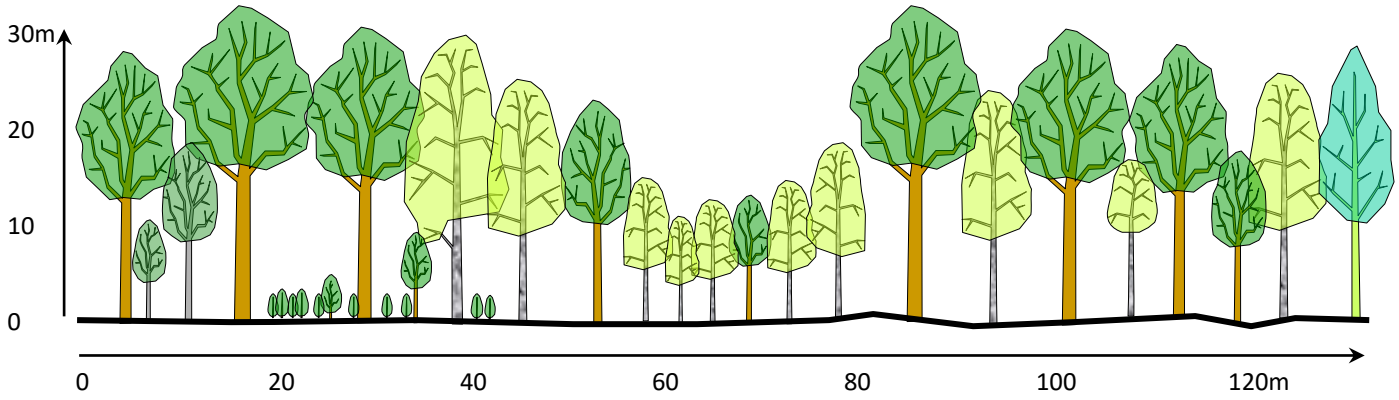
4. General management principles for the FDT

This FDT aims to produce high quality timber in a two-storey stand structure. POK as the more light demanding primary species must always dominate the overstorey. Careful selection of FC trees for timber quality is essential. Due to the good self-pruning ability, weak apical dominance and phototropic growth behaviour of POK management by Q/D approach is advised, achieving timber quality first and ensuring FC trees can grow into large dimensions later. POK and HBM are very compatible to grow in mixture (CS = 1) and both species respond well to thinning interventions throughout their lifetime. Thinning should start when the majority of FC trees have achieved the desired length of clean bole, usually at 16 – 18m top height and generally as crown thinning. Thinning at later stages must maintain a two-storey stand structure. Rotation length is driven by target DBH. LIMA / CCF methods should be the preferable option for final harvesting / restocking, diversifying the stand structure further.

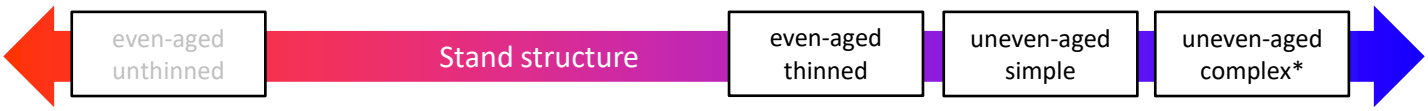
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha, or planting of 5000 – 10000 trees/ha, or direct seeding. Numbers can be reduced by planting 20 – 30 individual POK per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees. HBM is either planted throughout the POK matrix, around POK clusters, or may be introduced later by underplanting.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Cleaning or pollarding of aggressive infill if necessary. • Closed canopy must be maintained to ensure self-pruning and differentiation (remove no more than 5 – 10% of trees).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise the focus should shift to positive selection – carefully promote up to 200 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. Select 50 – 80 FC trees/ha, and apply crown thinning to release their crowns from competing neighbours. • Retain sub-dominant and suppressed trees to develop a diverse stand structure, consider underplanting if HBM has not been established together with POK.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop the understorey in order to suppress epicormic growth in POK, and to control ground vegetation. Prevent understorey trees from encroaching into the crown area of FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Apply irregular shelterwood methods for harvesting, or use selective target diameter harvesting to achieve a more complex stand structure. • Remove understorey immediately before harvesting and time operations with POK mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

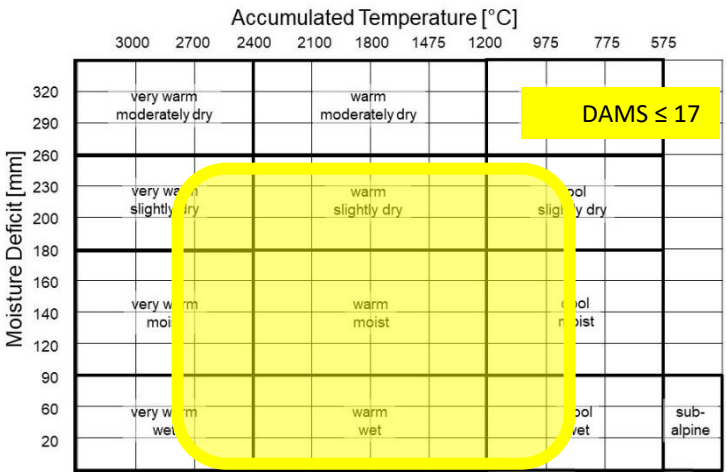
FDT 5.2.1 SOK and BI

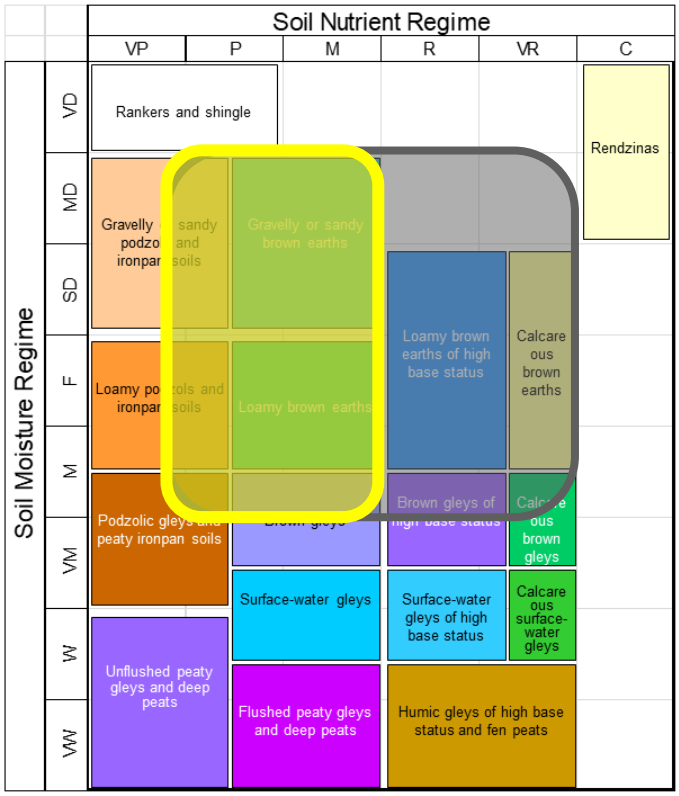


1. Structure and dynamics:
Single to multiple-storeyed stand of dominant SOK with BI in individual tree to small area (≤ 1 ha) mixture. Category C minor species may include BE, SP, ROW, ASP, AR and others according to local site conditions.
Species distribution: SOK 50 – 80% BI 20 – 50% minor species: 10 – 30%
Stands may be managed under LIMA / CCF regimes, with management aiming to create a diverse stand structure. Natural regeneration should account for all of the BI component and the majority of minor species; SOK is to be regenerated naturally wherever possible.



2. Ecological suitability:
Represents various successional stages of NVC types W16, W15, W17 and W4 in lowland and upland climatic zones. Suitable for poorer soils of sandy to sandy loam texture across a wide moisture range where SOK performs at the lower end of the GYC range and may be at risk of shake.





3. Management objectives:

Economic (SOK GYC < 6):	SOK – sawlogs, target DBH > 50cm in 120 – 180yrs, optional BI – sawlogs, target DBH > 30cm in 60 – 80yrs, optional
Environmental and social:	Diverse woodland of natural appearance providing a range of habitats for light demanding species and high conservation value. Presence of deadwood and veteran trees. Attractive to visitors because of its open structure and diversity.

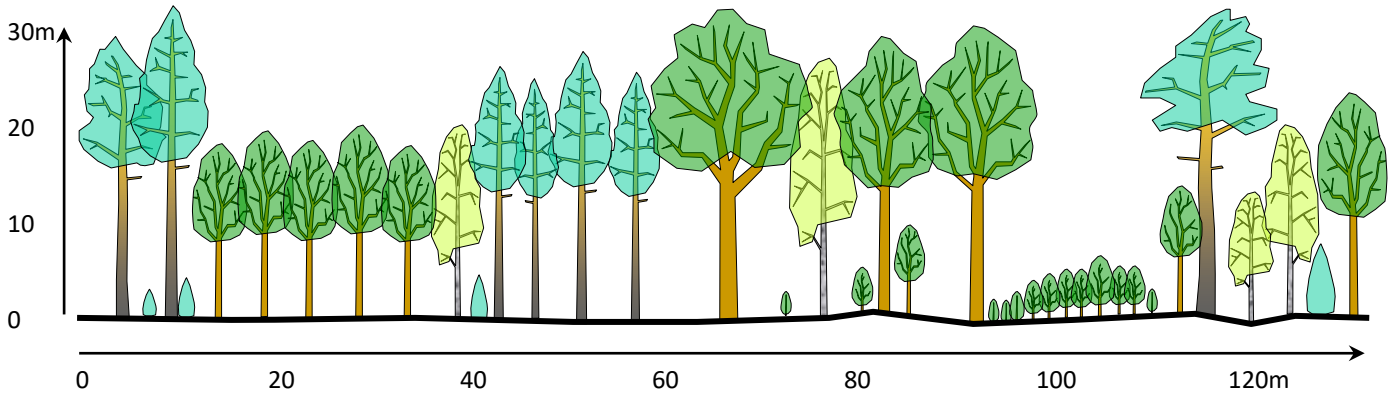
4. General management principles for the FDT

Species in this FDT are generally compatible to grow in mixture (CS = 2) but for timber quality spatial separation in groups to small areas will be preferable. SOK responds well to thinning interventions throughout its lifetime and the Q/D management approach with high initial stocking density may be used provided sawlog production is a viable option. BI will have to be managed on a much shorter rotation than SOK and therefore requires a different management strategy with wider initial spacing and earlier interventions if it is to be grown into sawlog dimensions. As a typical pioneer species BI will outgrow SOK at young age but lose its competitive advantage later, thinning interventions will have to adapt accordingly with regard to tree species and time. Crown thinning should be applied throughout, starting at 10 – 14m top height in BI and 16 – 18m in SOK. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

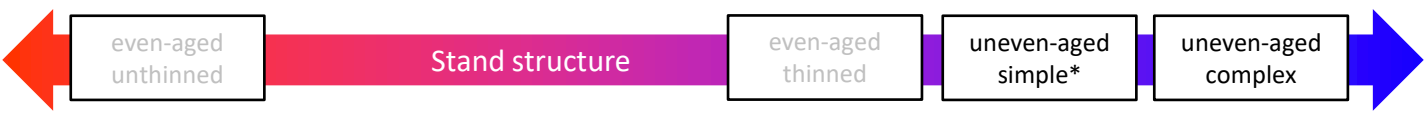
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha or planting of 2000 (BI) – 5000 (SOK) trees/ha. Most commonly SOK may be established in clusters (20 – 30 plants at 0.3 – 1m spacing) and BI recruited from natural infill.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• SOK: Negative selective respacing (removal of undesirable trees). • BI: Systematic respacing to about 1500 – 2000 trees/ha if necessary, cleaning or pollarding of aggressive BI overtopping promising SOK. • Regulation of species composition and minor species as required.
Pole stage	10 – 14	• SOK: Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning. • BI: Start thinning interventions, generally as crown thinning. Up to 300 FC trees/ha may be selected, pruning may be considered.
Pole to small timber stage	16 – 18	• SOK: Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. Select 80 – 100 FC trees/ha, and thin to release their crowns from competitive neighbours (crown thinning).
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Live crown length of FC / dominant trees should always remain > 50% of tree height. Apply crown thinning as long as necessary for the benefits of FC trees. • Assess potential for natural regeneration and decide on harvesting method when BI approaches target DBH; improve conditions if necessary. • Monitor occurrence and growth rate of BI regeneration, review FDT and / or supplement by planting if necessary.
Final harvesting and regeneration stage		• Time final harvesting operations in SOK with mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

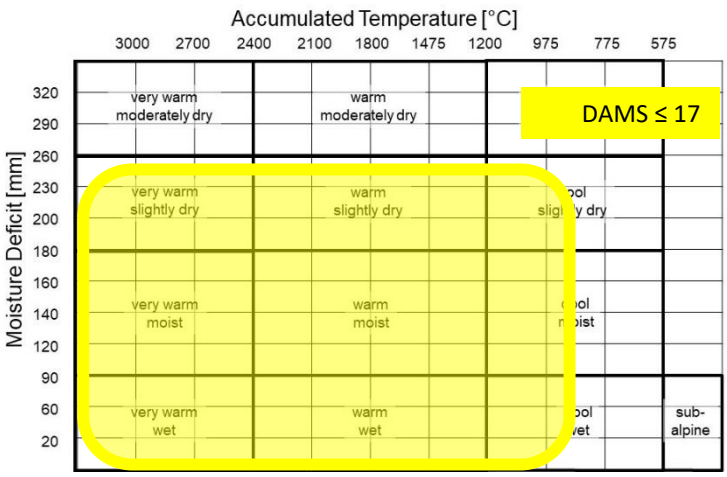
FDT 5.2.2 SOK and SP

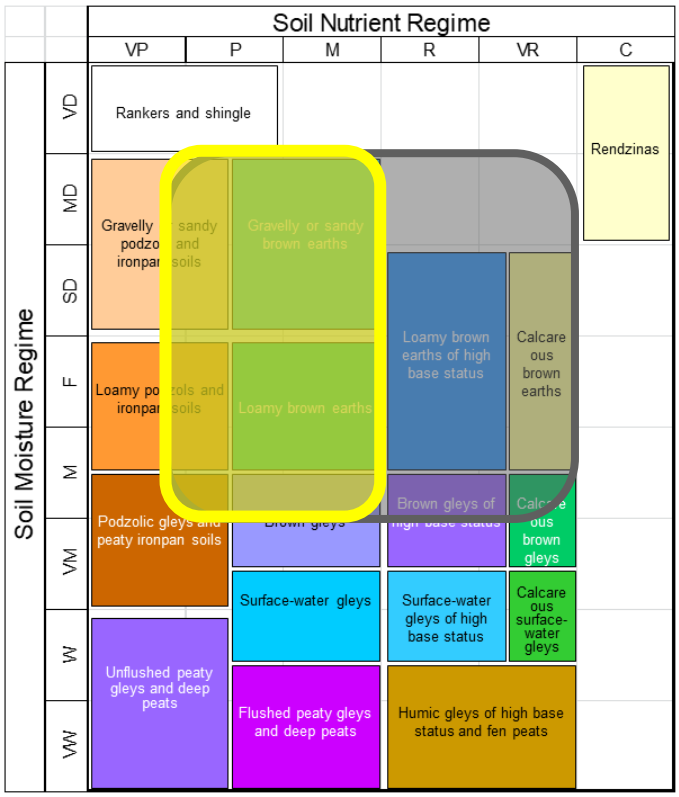


1. Structure and dynamics:
Mosaic of single-storeyed large groups or patches of SOK and SP of variable age, with individual trees or small groups of BI and other category C species as minor components.
Species distribution: SOK 50 – 70% SP: 20 – 40% minor species: 10 – 20%
SOK and SP will be managed in single cohorts on different rotations using LIMA. SP, BI and other minor species should propagate via natural regeneration, SOK may have to be planted if regeneration is insufficient.



2. Ecological suitability:
Represents the overlap between NVC types W18 and W17 or W16. This FDT belongs on nutrient poor sandy to sandy loam soils with low to intermediate water supply, where SOK performs at the lower end of the GYC range. Similar to FDT 2.1.5 but with reversed proportions of SOK and SP.





3. Management objectives:

Economic (SOK GYC < 6):	SOK – sawlogs, target DBH > 50cm in 120 – 180yrs, optional
	SP – sawlogs, target DBH > 50cm in 100 – 160yrs
Environmental and social:	Diverse woodland of natural appearance with habitats for light demanding species and high conservation value. Presence of deadwood and veteran trees. Attractive to visitors because of its open structure and diversity.

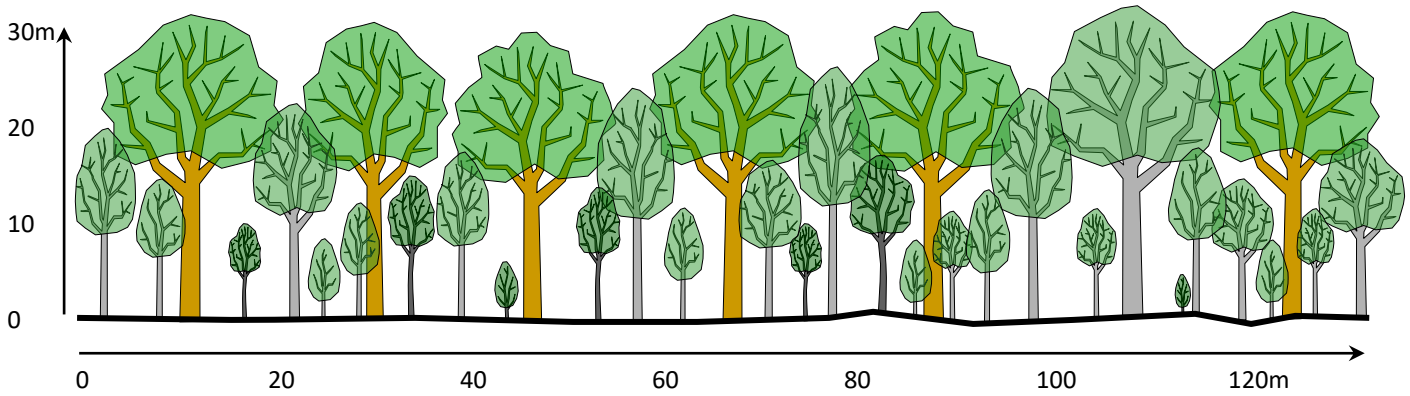
4. General management principles for the FDT

SOK and SP are very compatible (CS = 1) to grow in mixtures; the faster growth rate of SP being compensated by the slightly higher shade tolerance of SOK. Timber quality is variable in both species; it generally benefits from high initial stocking density and requires careful quality selection during respacing and thinning; SOK will also require growing in groups. Dominant trees of poor quality need to be eliminated by selective respacing, desirable FC trees promoted by thinning. SOK responds well to thinning interventions throughout its lifetime and the Q/D management approach with high initial stocking density may be used provided sawlog production is a viable option. The growth response of SP to thinning interventions peaks early in life and diminishes rapidly thereafter, therefore thinning needs to start earlier and its rotation may be considerably shorter than that of SOK. For both species crown thinning should be applied throughout. Thinning at later stages must aim to maintain tree stability and steady growth. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

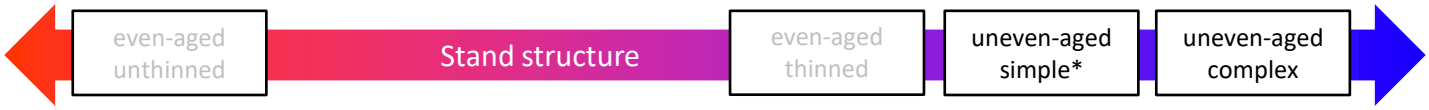
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 8000 trees/ha or natural regeneration. Whilst individual SP may be embedded in a surrounding matrix of SOK, SOK should be established at least in robust groups of > 25 trees at 0.3 – 1m spacing.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• Negative selective respacing (removal of undesirable trees), cleaning or pollarding of aggressive infill competing with promising SOK.
Pole stage	10 – 14	• SOK: Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning. • SP: First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. Up to 300 FC trees/ha may be selected, pruning may be considered.
Pole to small timber stage	16 – 18	• SOK: Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 100 FC trees/ha, and apply crown thinning to release their crowns from competitive neighbours. • Monitor competition between SOK and SP and adjust thinning accordingly. Focus on competition status of FC trees and maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. • Assess potential for natural regeneration and decide on harvesting method when SP approach target DBH – improve conditions if necessary. • Monitor occurrence and growth rate of SP regeneration, review FDT and / or supplement by planting if necessary.
Final harvesting and regeneration stage		• Time final harvesting operations in SOK with mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock. • Follow species specific guidance for SP / SOK dominated components.

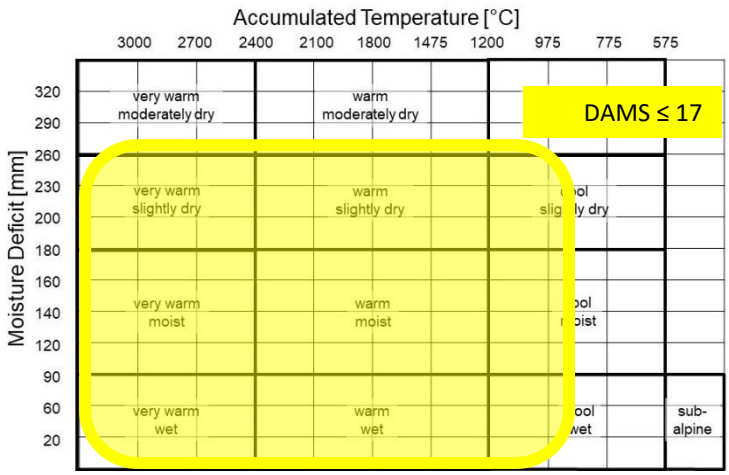
FDT 5.3.1 OK and BE

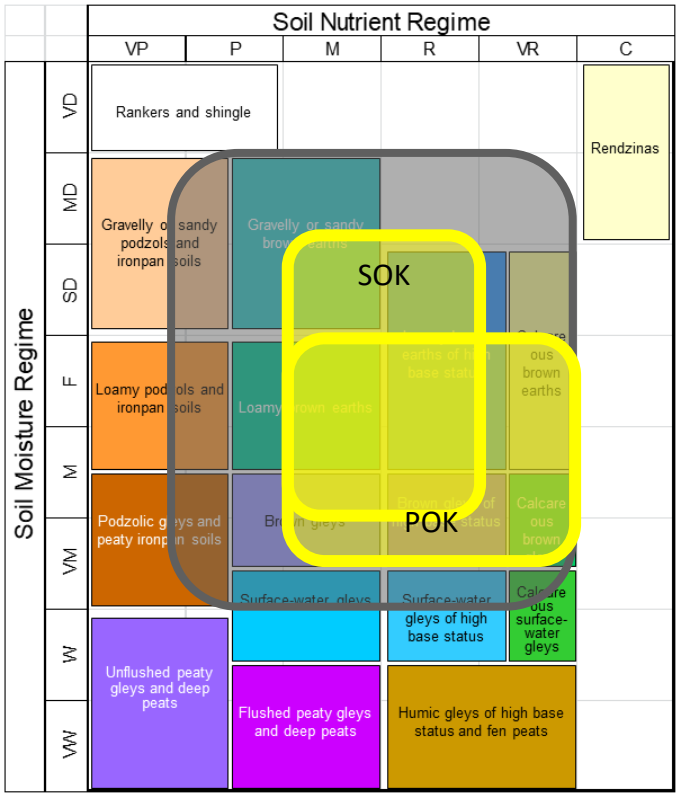


1. Structure and dynamics:
Two- or multi-storeyed stand of dominating OK with BE in single tree to small group mixture. BE occupies mainly the middle and understorey, some groups in overstorey are possible. Interspersed with single trees or small groups of category C minor species like HBM, SY, SLI, BI, ASP, ROW, HAZ and others.
Species distribution: OK 60 – 80% BE 20 – 40% minor species: < 10%
Likely originating from OK stands underplanted with BE, minor species from infill. Stands should be managed under LIMA / CCF regimes with best possible use of natural regeneration of OK.



2. Ecological suitability:
Resembles NVC types W8/9 and W10/11, or early stages of W12, W14 and W15. Suitable for a wide range of soils, with POK being preferable on moister, richer and heavier, and SOK on drier, poorer and lighter soils. A good option to diversify pure OK stands by enrichment planting.





3. Management objectives:

Economic (OK GYC > 4):	OK – optional, veneer / planking grade, target DBH > 70cm in 120 – 180yrs OK – sawlogs, target DBH > 60cm in 100 – 160yrs BE – sawlogs, target DBH > 50cm in 80 – 140yrs
Environmental and social:	Diverse woodland of natural appearance providing a range of habitats and high conservation value. BE element serves to add productivity, improve timber quality and control ground vegetation. Attractive to visitors because of its diverse structure and tree size.

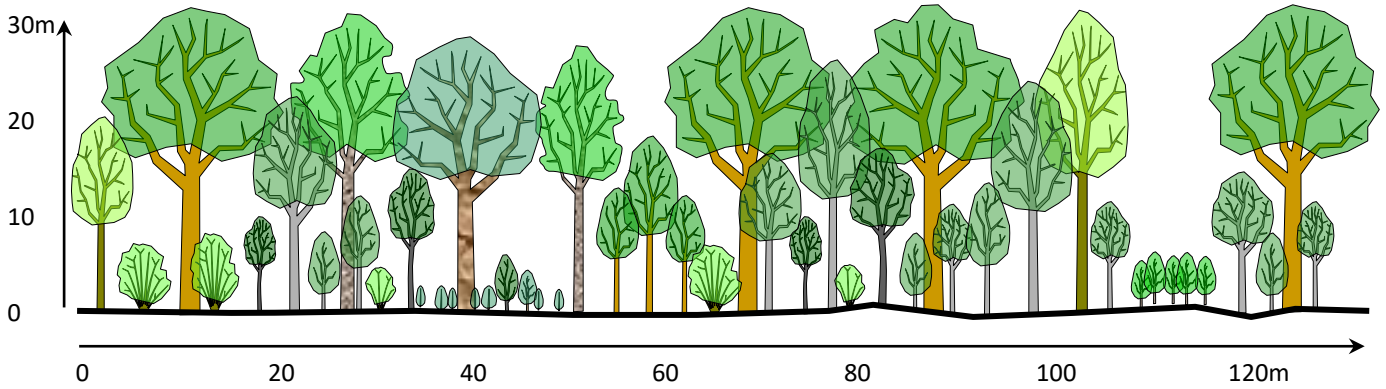
4. General management principles for the FDT

This FDT aims to produce high quality timber in a two-storey stand structure. OK as the more light demanding primary species must always dominate the overstorey. Careful selection of FC trees for timber quality is essential. Due to the good self-pruning ability, weak apical dominance and phototropic growth behaviour of OK management by Q/D approach is advised, achieving timber quality first and ensuring FC trees can grow into large dimensions later. Thinning should start when the majority of FC trees have achieved the desired length of clean bole, usually at 16 – 18m top height and generally as crown thinning. OK and BE are very compatible to grow in mixture (CS = 1) and both species respond well to thinning interventions throughout their lifetime. Thinning at later stages must maintain a two-storey stand structure and not let BE encroach into the OK canopy. Rotation length is driven by target DBH. LIMA / CCF methods should be the preferable option for final harvesting / restocking, diversifying the stand structure further.

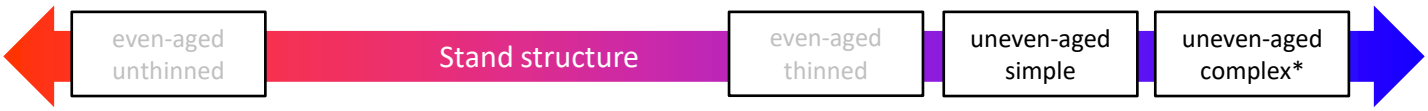
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha, planting of 5000 – 10000 trees/ha, or direct seeding. Numbers can be reduced by planting 20 – 30 individual OK per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees. BE should be introduced by underplanting later.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Cleaning or pollarding of aggressive infill if necessary. • Closed canopy must be maintained to ensure self-pruning and differentiation (remove no more than 5 – 10% of trees).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise the focus should shift to positive selection – carefully promote up to 200 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. Select 50 – 80 FC trees/ha, and crown thin to release their crowns from competitive neighbours. • Underplant with < 3000 BE trees/ha after first or second thinning in OK. BE may be placed throughout OK matrix or concentrated around FC trees. • Protect BE against animals / plants as necessary.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop BE understorey in order to suppress epicormic growth in OK, and to control ground vegetation. Suitable individual BE may be managed for timber (FC trees). Apply crown thinning to prevent BE from encroaching into the crown area of OK FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Apply fast irregular shelterwood methods for harvesting, or use selective target diameter harvesting to achieve a more complex stand structure. • Remove BE understorey immediately before harvesting and time operations with OK mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

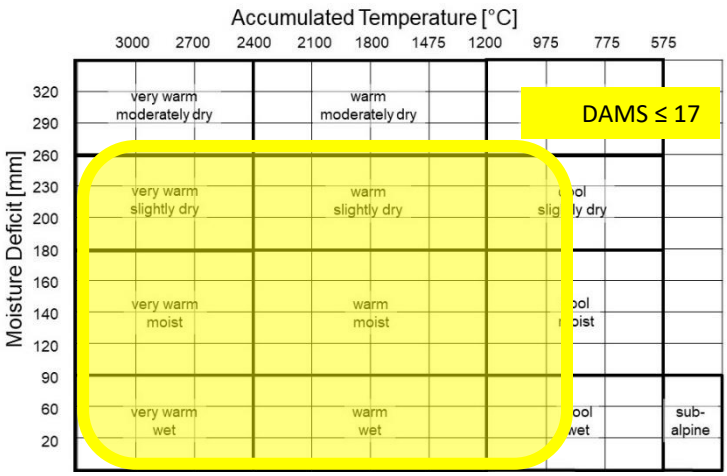
FDT 5.3.2 OK and long-lived broadleaves (XBLL)

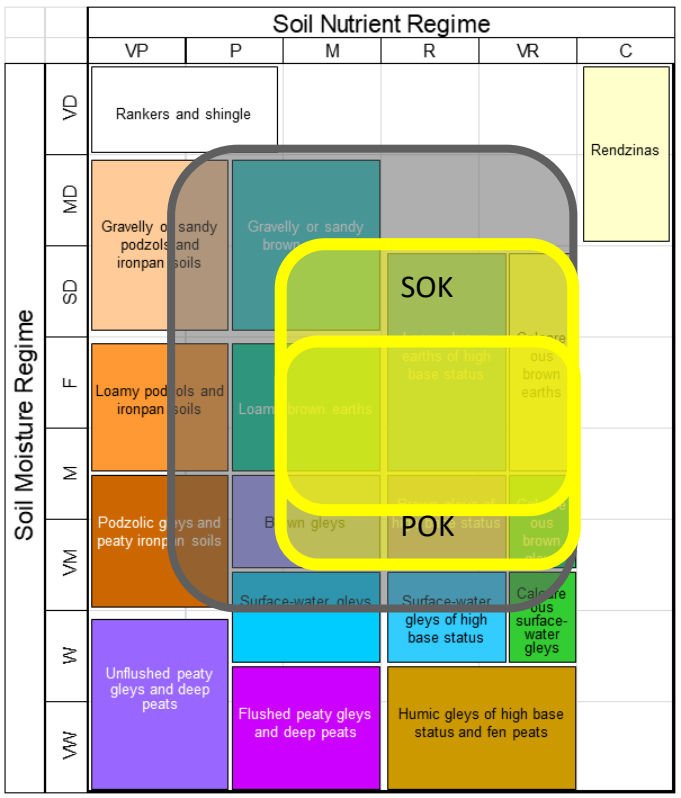


1. Structure and dynamics:
Multi-storeyed stand of dominating OK with AH, SY, LI, and others in single tree to small group mixture. BE, HBM, HAZ and FM are also present and occupy mainly the middle and understorey. Light demanding category C minor species such as BI, WCH, and others occupy gaps and edges.
Species distribution: OK 50 – 70% XBLL 30 – 50% minor species: < 30%
Likely originating from OK stands underplanted with HBM or BE, other species from infill. Management should use LIMA / CCF to make best possible use of natural regeneration.



2. Ecological suitability:
Resembles NVC types W8 and W10 but also includes elements of W14 and W15. Suitable for a wide range of soils, with POK being preferable on moister, richer and heavier, and SOK on drier, poorer and lighter soils. A good option for conversion of pure OK stands requiring diversification by enrichment planting.





3. Management objectives:

Economic (OK GYC > 4):	OK – optional, veneer / planking grade, target DBH > 70cm in 120 – 160yrs
	OK – sawlogs, target DBH > 60cm in 100 – 140yrs
	XBLL – sawlogs / pulp / fuel
Environmental and social:	Very diverse woodland of natural appearance and high conservation value. XBLL serve to add productivity, improve timber quality and control ground vegetation. Attractive to visitors due to its diverse structure and tree size.

FDT 5.3.2 OK and long-lived broadleaves (XBLL)

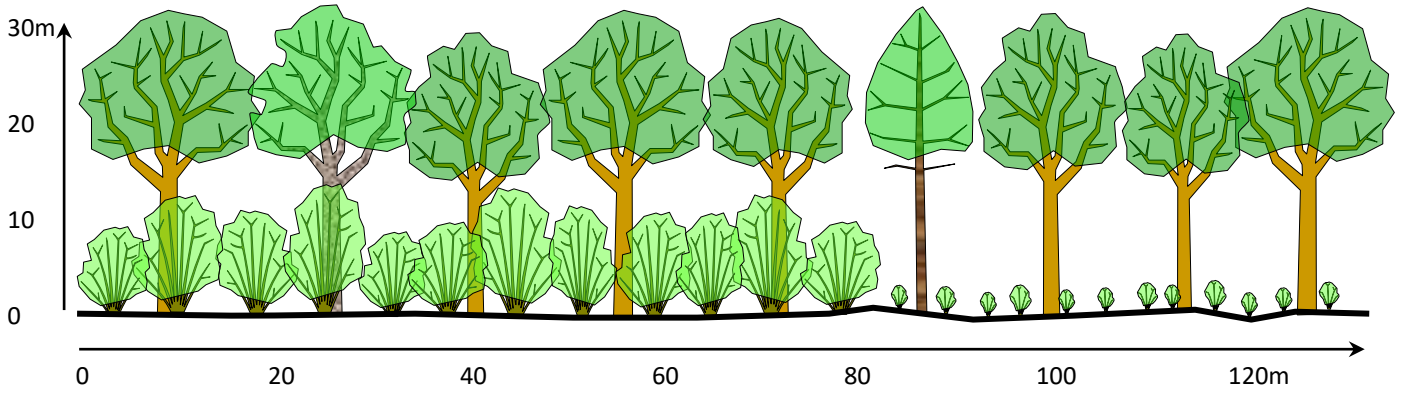
4. General management principles for the FDT

This FDT aims to produce high quality timber in a multiple-storey stand structure. OK and light demanding secondary species should dominate the overstorey whereas shade tolerant species are mostly kept in the middle and understorey. Mixture compatibility between OK and XBLL will vary depending on species (CS = 2 for LI, CS = 4 for SY); less competitive species require more support by interventions and will generally benefit from being established in groups rather than intimate mixture. Careful selection of FC trees for timber quality is essential. Depending on species and spacing, clean boles in FC trees may be achieved by Q/D approach or artificial pruning. Interventions will have to be small scale and selective in nature, leading to a self-sustaining complex CCF system. The Timeline below should therefore be interpreted as applicable to individual cohorts rather than the entire stand.

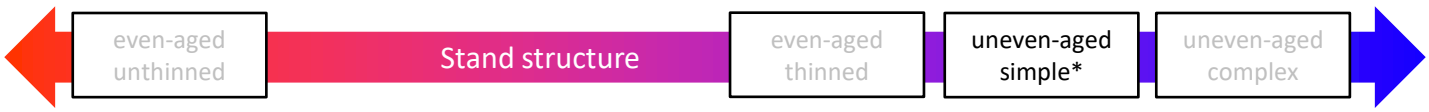
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• OK: Natural regeneration in densities of > 10000 seedlings/ha or cluster planting (20 – 30 plants per cluster at 0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of OK FC trees. • XBLL: Natural regeneration or planting according to species specific guidance. Shade tolerant XBLL may also be introduced by underplanting at a later stage.
Young stand	< 4	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings if regeneration is sparse.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Cleaning or pollarding of aggressive infill if necessary. • Maintain closed canopy in groups of dense natural regeneration. • Start pruning of promising FC tree candidates where self-pruning cannot be achieved (*i.e.* in WCH or wide spacing scenarios).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise shift focus to positive selection – carefully promote up to 200 FC (OK + XBLL) tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 50 – 80 FC trees/ha, and thin to release their crowns from competitive neighbours (crown thinning). • Retain sub-dominant and suppressed trees to develop a diverse stand structure, consider underplanting if understorey is absent.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop the understorey in order to suppress epicormic growth in OK, and to control ground vegetation. Prevent understorey trees from encroaching into the crown area of FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Selectively harvest FC trees as they reach target DBH. • Time operations with OK mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

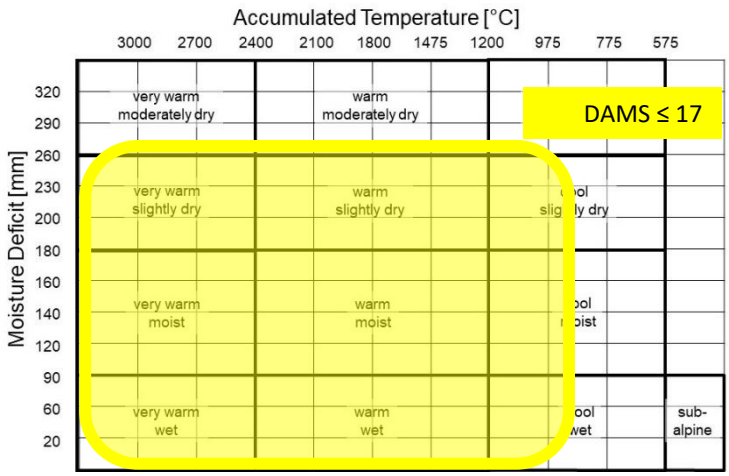
FDT 5.3.3 OK (XBLL) and HAZ

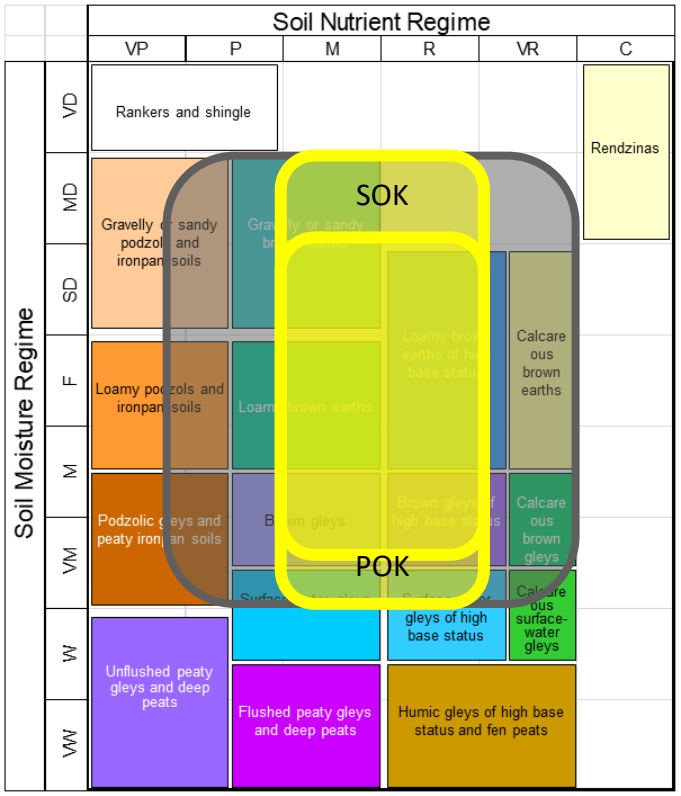


1. Structure and dynamics:
Two-storeyed stand of dominating OK (XBLL) with HAZ coppice understorey. Category C minor species such as BI, WCH, AH, WST and others are present mostly in the overstorey.
Species distribution: OK 80 – 100% HAZ (abundant coppice) minor species: < 20%
Coppice with standards system. OK is managed over several HAZ coppice rotations and regenerated naturally or by planting, other species from infill.



2. Ecological suitability:
Contains elements of NVC types W8 and W10.
Suitable for a wide range of soils, with POK being preferable on moister, richer and heavier, and SOK on drier, poorer and lighter soils. In practice these woodlands are often neglected and likely to develop into a different FDT.





3. Management objectives:

Economic:	OK – sawlogs, target DBH > 50cm in 100 – 140yrs HAZ – coppice products
Environmental and social:	Diverse, open woodland providing a range of habitats and high conservation and cultural value. Apart from its conservation and cultural value HAZ may help to maintain soil fertility, improve timber quality and control ground vegetation.

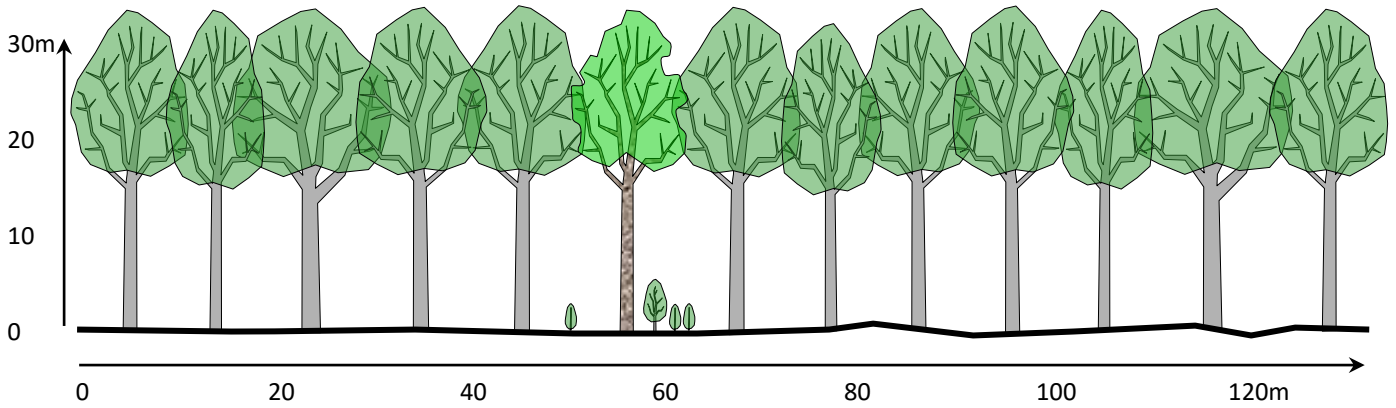
4. General management principles for the FDT

This FDT is designed to accommodate HAZ coppice scenarios under OK and occasionally XBLL canopy, where OK and XBLL are managed as an even-aged stand over several coppice rotations. Mixture compatibility between OK and XBLL will vary depending on species; less competitive species require more support by interventions and will generally benefit from being established in groups rather than intimate mixture. Careful selection of FC trees for timber quality is essential. Management of young stands should aim to develop timber quality in OK (XBLL); thinning should start when the majority of FC trees have achieved the desired length of clean bole, usually at 16 – 18m top height and generally as crown thinning. If not already present, the HAZ understorey should be established after thinning in OK has commenced and be managed on a small scale rotational system, leading to a mosaic-like structure of an even-aged OK (XBLL) stand over varying stages of coppice management.

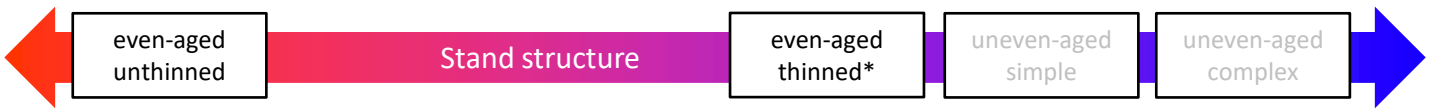
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• OK: Natural regeneration in densities of > 10000 seedlings/ha, or direct seeding (200 – 400 kg/ha), or planting of 5000 – 10000 trees/ha. Numbers can be reduced by planting 20 – 30 individual OK per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees. • XBLL: Natural regeneration or planting according to species specific guidance. HAZ may be introduced at a later stage if not present on site.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Cleaning or pollarding of aggressive infill if necessary. • Closed canopy must be maintained to ensure self-pruning and differentiation (remove no more than 5 – 10% of trees).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise the focus should shift to positive selection – carefully promote up to 200 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. Select 50 – 80 FC trees/ha and apply crown thinning to release from competitive neighbours. • If not already present, establish HAZ at 1500 – 2000 trees/ha by underplanting after first thinning in OK.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Manage HAZ on small scale rotational coppice system, avoid clearing large areas from understorey. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Apply irregular shelterwood methods (as FC trees reach target DBH) for final harvesting. • Remove understorey immediately before harvesting and time operations with OK mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

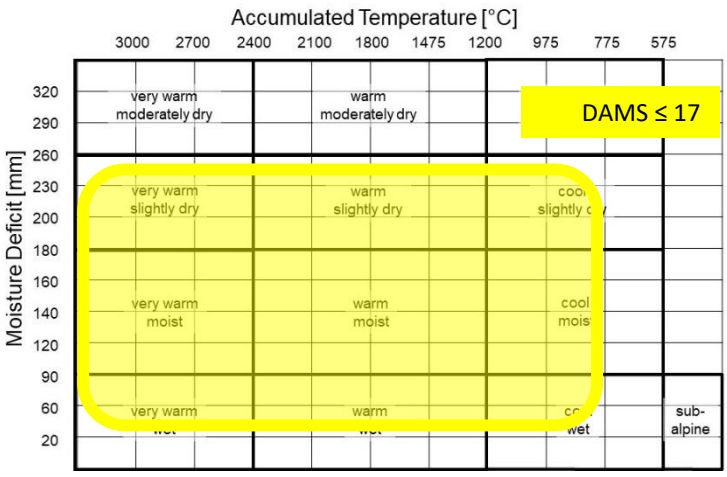
FDT 6.1.1 BE

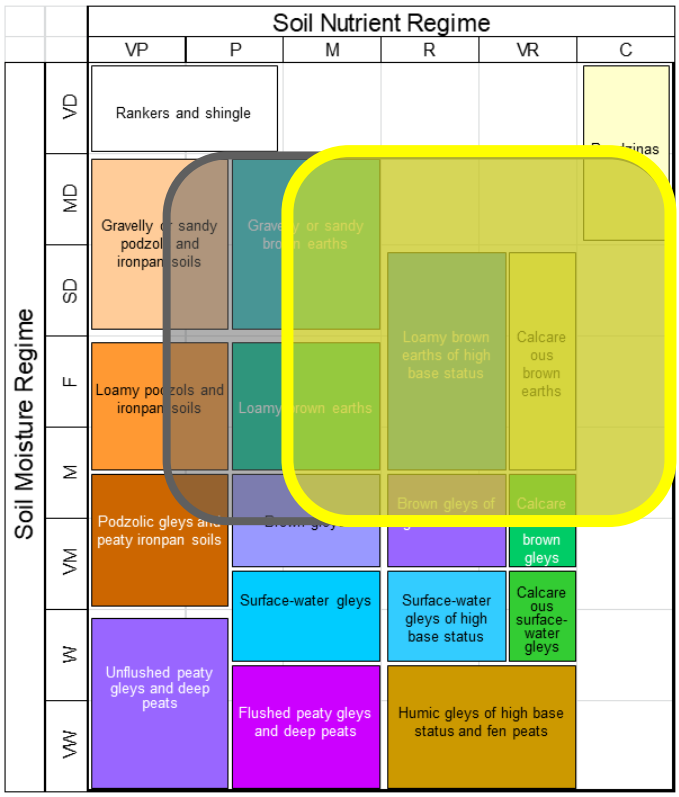


1. Structure and dynamics:
Single-storeyed BE stand with category A minor species such as OK, SY, AH, WCH, EM, BI and others according to site conditions. Shade tolerant minor species may occupy the middle and understorey.
Species distribution: BE 90 – 100% minor species: < 10%
Stands may be managed under clearfell-and-restock regime or simple CCF / LIMA options such as large scale shelterwood methods in order to make use of BE natural regeneration. Minor species regenerating naturally.



2. Ecological suitability:
Represents NVC types W12, W14, W15 and provides niches for elements of W13 on calcareous soils. Suitable for well aerated, deep soils of loamy texture and better nutrient supply. Unsuitable for wet soils and frost hollows.





3. Management objectives:

Economic (GYC > 4):	BE – sawlogs, target DBH > 50cm in 100 – 140yrs, optional (grey squirrels)
Environmental and social:	Attractive woodlands due to tree size, structure (“cathedral effect”), lack of ground vegetation, spring aspect and autumn colours. Presence of deadwood and veteran trees. Minor species elements increase habitat diversity and improve amenity aspects.

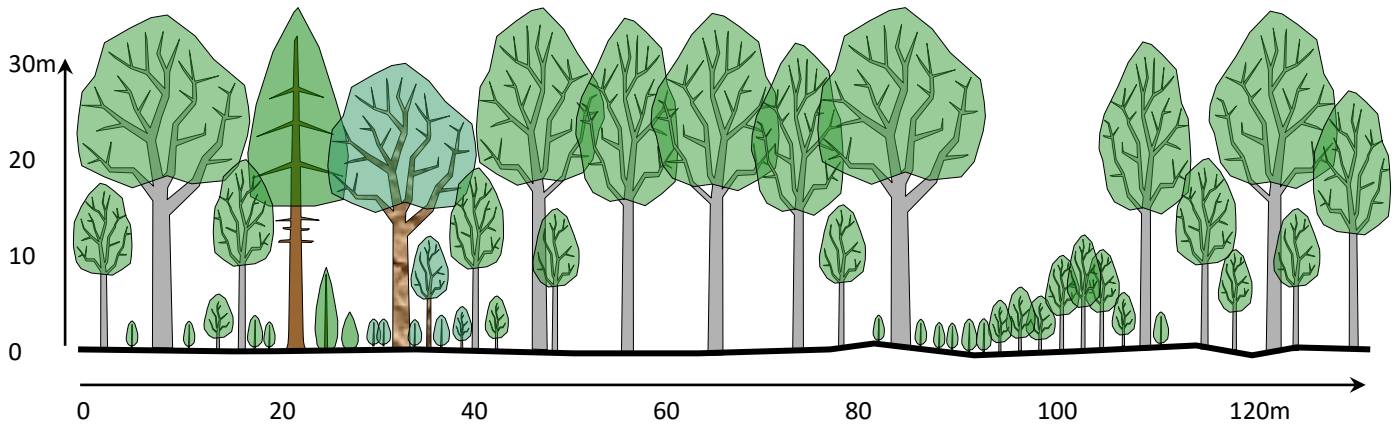
4. General management principles for the FDT

This FDT should be used where clearfell-and-restock scenarios with BE are envisaged or where an even-aged structure is preferable. A no thinning approach is possible but will limit management options and achievable target DBH; the presence of grey squirrels may also restrict management objectives. For sawlog production careful selection of FC trees is essential. Due to the good self-pruning ability, weak apical dominance and phototropic growth behaviour of BE management by Q/D approach is advised, achieving timber quality first and ensuring FC trees can grow into large dimensions later. Management of young stands should aim to develop timber quality; thinning should start when the majority of FC trees have achieved the desired length of clean bole, usually at 16 – 18m top height and generally as crown thinning. BE is very prone to developing wolf trees; these should be removed as early as possible. Due to the high crown plasticity a clumped occurrence of FC trees is more acceptable than in other species. BE also responds very well to thinning throughout its life, meaning that late thinning interventions can still produce a considerable growth boost. On suitable sites the use of natural regeneration should be considered.

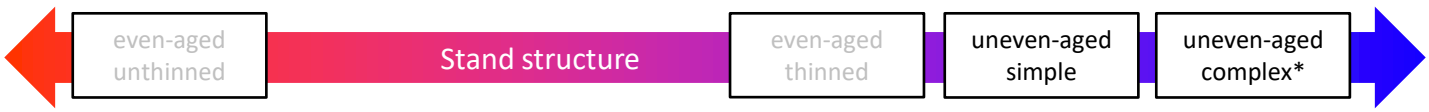
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha, planting of 6000 – 10000 trees/ha, or direct seeding. Numbers can be reduced by planting 20 – 30 individual BE per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Closed canopy must be maintained to ensure self-pruning and differentiation (remove no more than 5 – 10% of trees).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise the focus should shift to positive selection – carefully promote up to 250 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. • Select 100 – 130 FC trees/ha, and thin to release their crowns from competitive neighbours (crown thinning). In contrast to most other XBLL a clumped occurrence of FC trees is acceptable. Also target remaining wolf trees as these may become difficult to remove later.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Plan for final harvesting when FC trees approach target DBH. • Assess potential for natural regeneration and improve conditions if necessary, review suitability of FDT and consider LIMA / CCF methods as appropriate.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

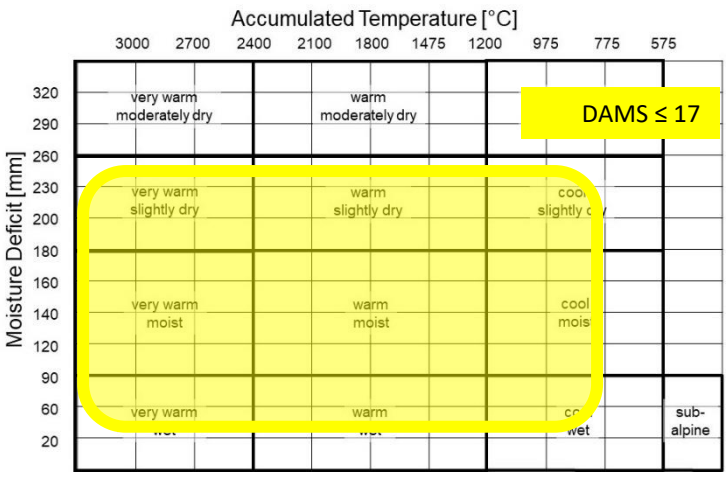
FDT 6.1.2 BE

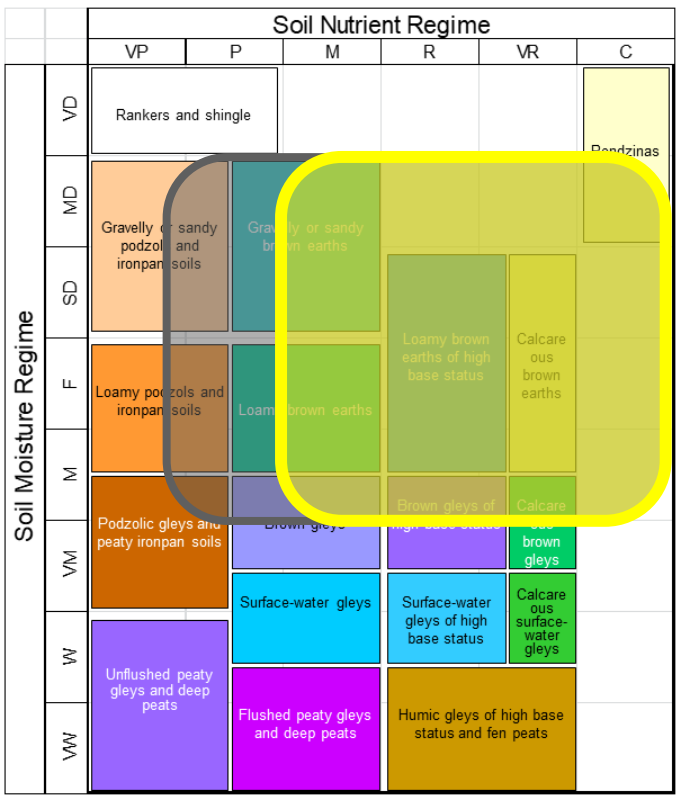


1. Structure and dynamics:
Multiple storeyed BE stand with individual trees or groups of category A minor species such as OK, SY, AH, WCH, EM, ROW, BI, NS and others.
Species distribution: BE 80 – 90% minor species: 10 – 20%
Stands may be managed under small scale clearfell-and-restock (LIMA) or CCF regimes, with management aiming to create a complex stand structure. Natural regeneration is to be used wherever possible and should account for the majority of BE and minor species component.



2. Ecological suitability:
Represents NVC types W12, W14, W15 and provides niches for elements of W13 on calcareous soils.
Suitable for well aerated, deep soils of loamy texture and better nutrient supply. Unsuitable for wet soils.





3. Management objectives:

Economic (GYC > 4):	BE – sawlogs, target DBH > 50cm in 100 – 160yrs, optional (grey squirrels)
Environmental and social:	Attractive woodlands due to tree size, diverse structure, lack of ground vegetation, spring aspect and autumn colours. Presence of deadwood and veteran trees. Minor species elements increase habitat diversity and improve amenity aspects.

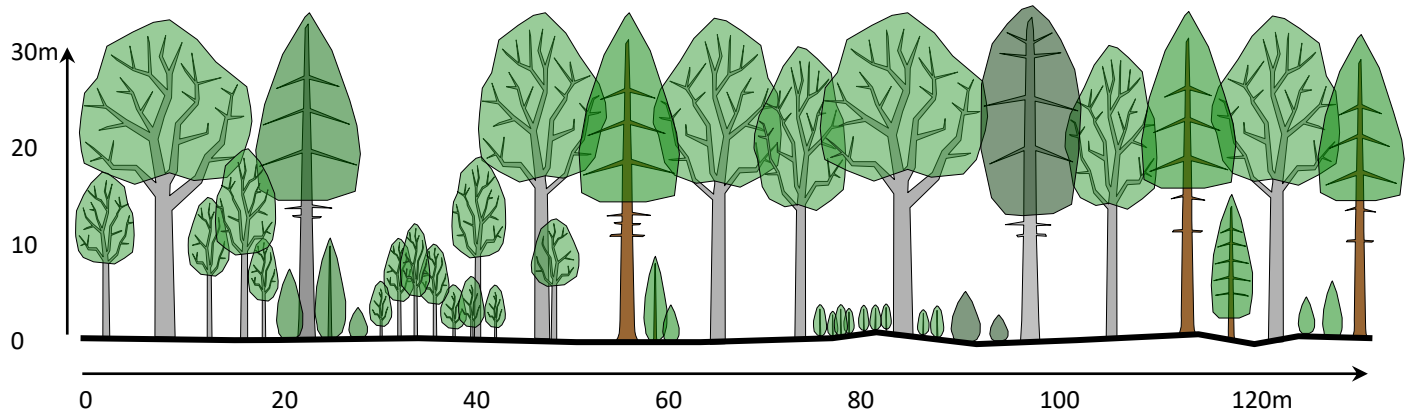
4. General management principles for the FDT

This FDT is suited to LIMA / CCF scenarios where natural regeneration is widely used and more structural diversity is desirable. Options range from selection systems using target diameter harvesting to simpler structures such as uniform shelterwoods. The presence of grey squirrels may restrict management objectives. For sawlog production careful selection of FC trees is essential. Due to the good self-pruning ability, weak apical dominance and phototropic growth behaviour of BE management by Q/D approach is advised, achieving timber quality first and ensuring FC trees can grow into large dimensions later. Management of young stands should aim to develop timber quality; thinning should start when the majority of FC trees have achieved the desired length of clean bole, usually at 16 – 18m top height and generally as crown thinning. BE is very prone to developing wolf trees; these should be removed as early as possible. Due to the high crown plasticity a clumped occurrence of FC trees is more acceptable than in other species. BE also responds very well to thinning throughout its life, meaning that late thinning interventions can still produce a considerable boost in growth.

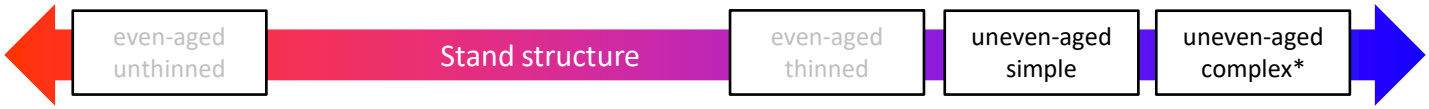
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha, planting of 6000 – 10000 trees/ha, or direct seeding. Numbers can be reduced by planting 20 – 30 individual BE per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Closed canopy must be maintained to ensure self-pruning and differentiation (remove no more than 5 – 10% of trees).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise the focus should shift to positive selection – carefully promote up to 250 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. • Select 100 – 130 FC trees/ha, and thin to release their crowns from competitive neighbours (crown thinning). In contrast to most other XBLL a clumped occurrence of FC trees is acceptable. Also target remaining wolf trees as these may become difficult to remove later.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method (simple or complex) to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method, time with mast years if possible. • In shelterwood scenarios, reduce BA to 30m^2/ha initially and then further once regeneration has established. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

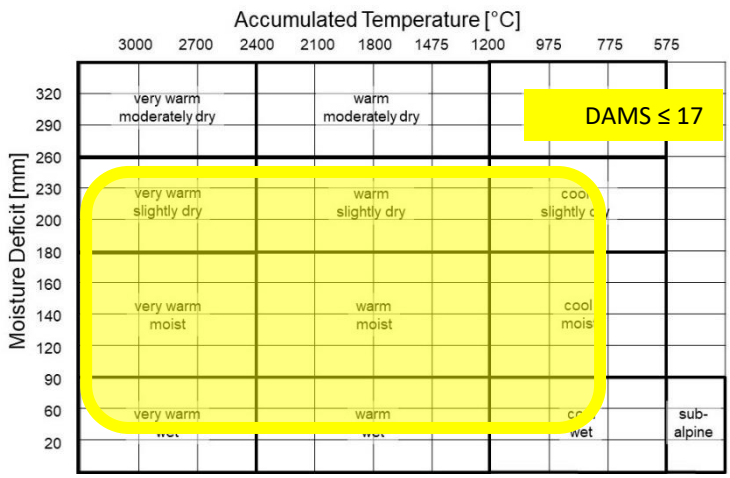
FDT 6.1.3 BE and shade tolerant conifers (XCST)

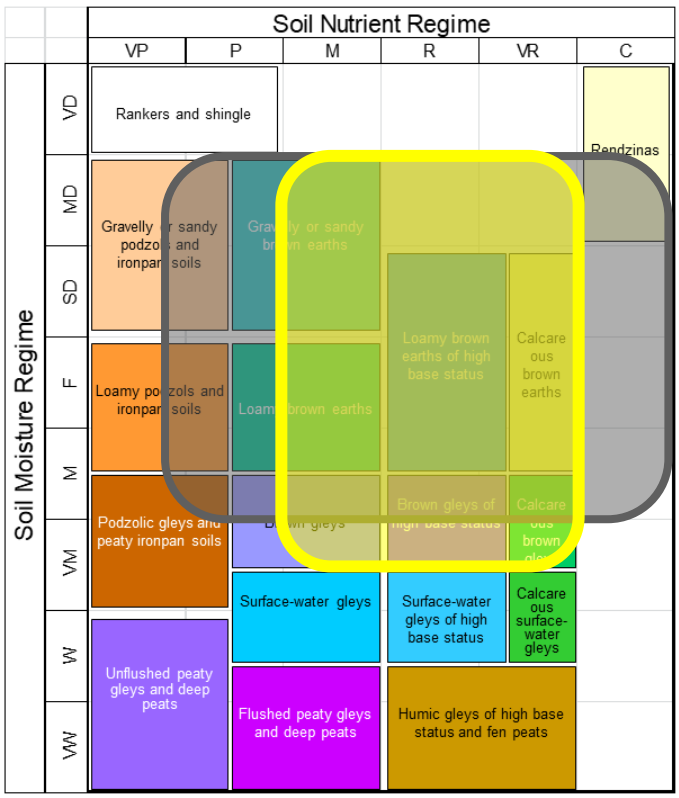


1. Structure and dynamics:
Multiple storeyed stand of BE with admixed XCST such as NS, SF, DF and others. Mixture may range from individual trees to small areas. Supplemented by minor species of category A such as OK, SY, ROW, BI, ASP and others according to site conditions.
Species distribution: BE 50 – 70% XCST 30 – 50% minor species: 10 – 30%
The complex stand structure requires small scale interventions under a CCF regime, with widespread use of natural regeneration for all species involved.



2. Ecological suitability:
Represents no current NVC type but contains important components of W14, W15 and provides niches for elements of W9, W10 and W11. This FDT belongs on well aerated, deep soils of loamy texture and at least medium nutrient supply. Self-sustaining through continuous forest cover.





3. Management objectives:

Economic (BE GYC < 10): BE – sawlogs, target DBH > 50cm in 100 – 160yrs, optional (grey squirrels)
XCST – sawlogs, target DBH > 50cm in 80 – 140yrs

Environmental and social: Complex forest structure provides habitats for a range of species and lends itself to low-impact management. Structural and species diversity improve stability with regard to risk factors. Attractive to visitors because of its diverse structure, broadleaved component and autumn colours.

FDT 6.1.3 BE and shade tolerant conifers (XCST)

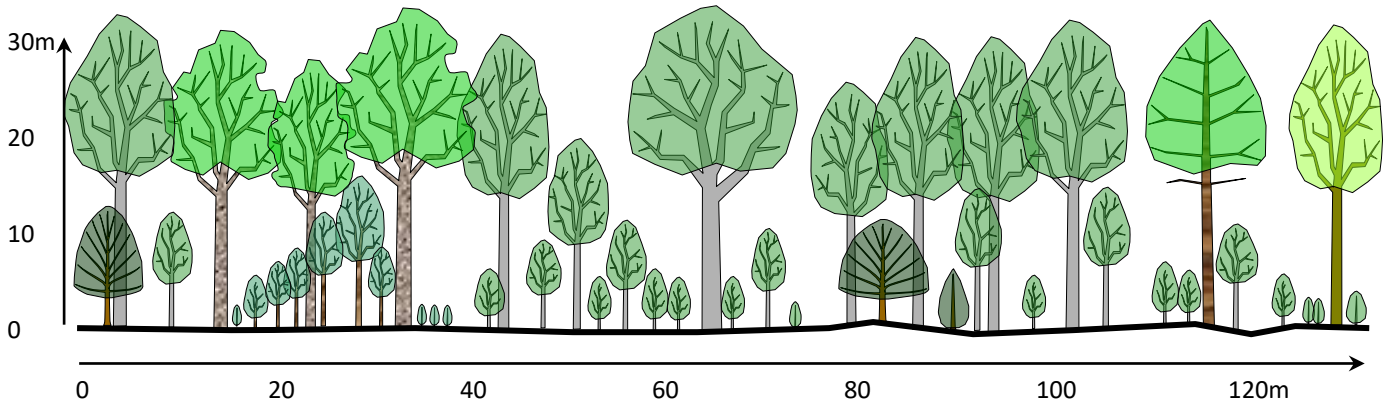
4. General management principles for the FDT

Most XCST species are compatible (CS = 2) to grow in mixture with BE; those which considerably exceed BE in final height (e.g. DF, WH) are slightly less so (CS = 3) and greater attention must therefore be paid to mixture design and species proportions. Management of young stands must aim to develop timber quality in BE, and individual tree stability in XCST. Stands originating from dense natural regeneration will require respacing in order to steer species composition and develop good timber quality and tree stability. Careful selection of BE FC trees is essential, as is the early removal of wolf trees. Due to the high crown plasticity a clumped occurrence of BE FC trees is more acceptable than in other species. All species will respond well to thinning throughout their lifetime. Whilst thinning in BE should commence when FC trees have achieved the desired length of clean bole (usually at around 16 – 18m top height) XCST need earlier interventions in order to maintain tree stability. Crown thinning should be used throughout. LIMA / CCF methods are the preferable option for final harvesting / restocking on sites conducive to natural regeneration, leading to a complex structure in most cases.

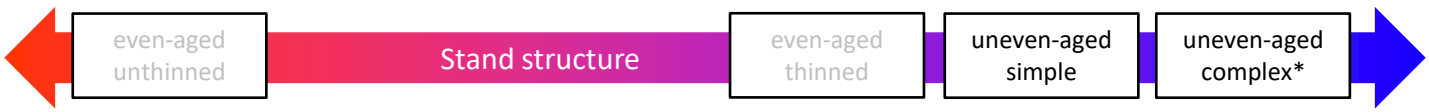
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• BE: Natural regeneration in densities of > 10000 seedlings/ha or planting of 6000 – 10000 trees/ha. Numbers can be reduced by planting 20 – 30 individual BE per cluster (0.3 – 1m spacing), with the number of clusters corresponding to the envisaged number of FC trees. • XCST: Natural regeneration or planting of < 3000 trees/ha.
Young stand	< 3	• Protection against animals / plants as necessary. • XCST: Systematic respacing if N > 3000 trees/ha at 1 – 2m tree height. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	6 – 10	• BE: Negative selective respacing – removal of wolf and other undesirable trees. Maintain closed canopy to facilitate self-pruning.
Pole stage	10 – 14	• BE: Continue negative respacing if necessary, otherwise shift focus to positive selection – carefully promote up to 250 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process. • XCST: First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape.
Pole to small timber stage	16 – 18	• BE: Thinning interventions start when the majority of FC tree candidates have reached the desired length of clean bole. • Select 100 – 200 FC trees/ha (BE + XCST), and continue crown thinning at height growth intervals of 3m. Focus on competition status of FC trees and maintain target species composition. A clumped occurrence of FC trees is acceptable for BE, but not for XCST.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF method (simple or complex) to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

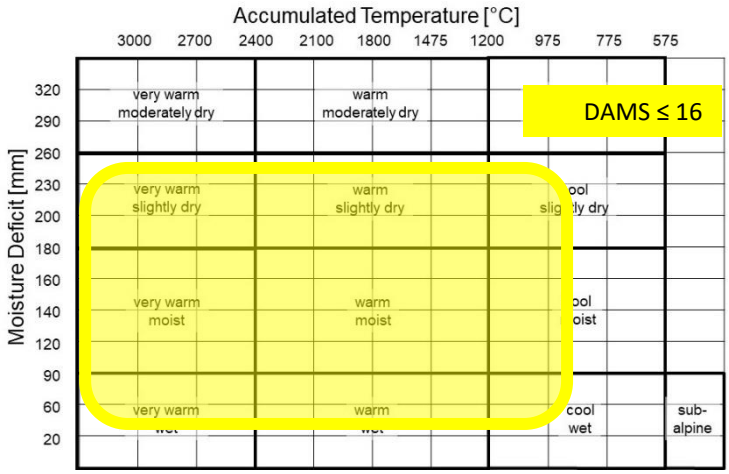
FDT 6.1.4 BE and long-lived broadleaves (XBLL)

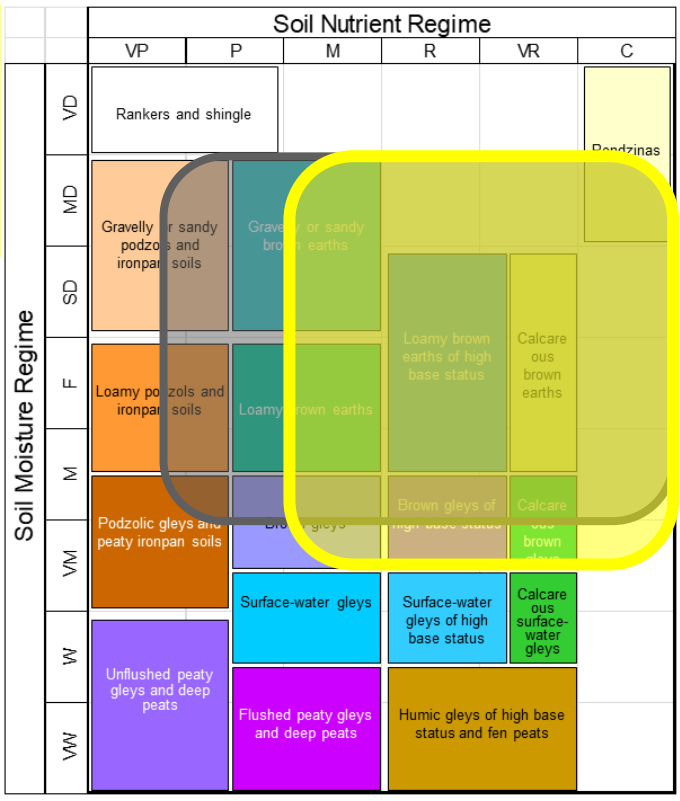


1. Structure and dynamics:
Multiple storeyed stand of dominating BE with admixed XBLL such as AH, SY, EM, LI, WCH and other species such as YEW in large groups to small areas, exceptionally also as dominant individual trees. Supplemented by category A minor species according to site conditions.
Species distribution: BE 50 – 70% XBLL 30 – 50% minor species: 10 – 30%
The complex stand structure requires small scale interventions under a CCF regime, with widespread use of natural regeneration for all species involved.



2. Ecological suitability:
Resembles NVC types W14, W12 and W13 and provides niches for elements of W8 and W9. Suitable for deep soils of best nutrient supply including calcareous soils. Self-sustaining through continuous forest cover.





3. Management objectives:

Economic (BE GYC > 6):	BE – sawlogs, target DBH > 50cm in 100 – 140yrs, optional (grey squirrels) XBLL – veneer / joinery grade / logs / pulp / biomass
Environmental and social:	Complex forest structure provides habitats for a range of species and lends itself to low-impact management. Structural and species diversity improve stability with regard to risk factors. Attractive to visitors because of its diverse structure, spring aspect and autumn colours.

FDT 6.1.4 BE and long-lived broadleaves (XBLL)

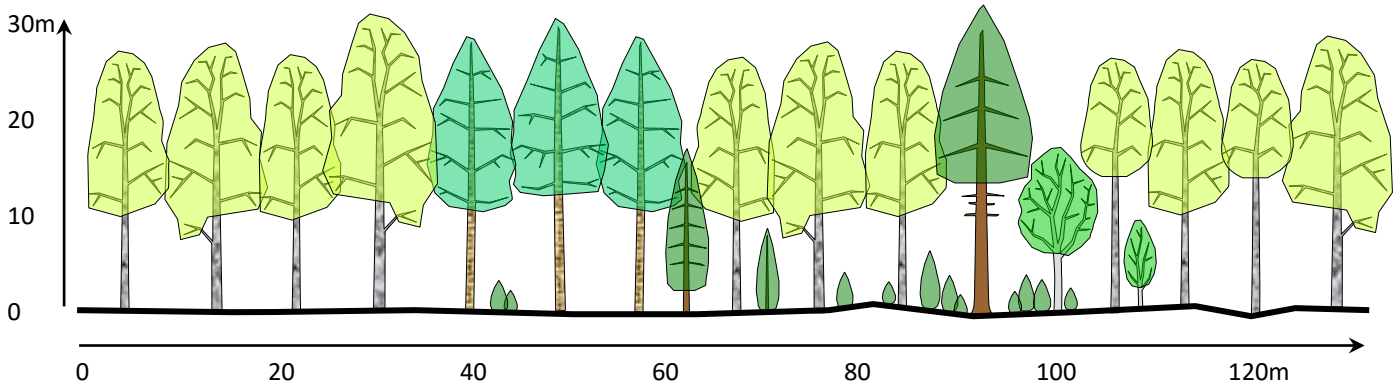
4. General management principles for the FDT

This FDT aims to produce high quality timber in a multiple-storey stand structure. In contrast to other FDTs the higher economic value is likely to be in the secondary (XBLL) component. Mixture compatibility between BE and XBLL will vary depending on species (CS = 2 for LI, CS = 3 for AH / SY / WCH). Timber quality and competitiveness of XBLL will benefit from being established in robust groups rather than intimate mixture; less competitive species may also require continuous support by thinning intervention. Careful selection of FC trees for timber quality is essential. Depending on species and spacing, clean boles in FC trees may be achieved by Q/D approach or artificial pruning. Interventions will have to be small scale and selective in nature, leading to a self-sustaining complex CCF system. The Timeline below should therefore be interpreted as applicable to individual cohorts rather than the entire stand.

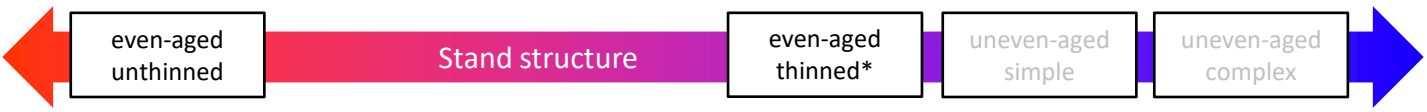
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• BE: Natural regeneration in densities of > 10000 seedlings/ha, planting of 6000 – 10000 trees/ha, or direct seeding. Numbers can be reduced by cluster planting of 20 – 30 individual BE (0.3 – 1m spacing). • XBLL: Natural regeneration or planting in large groups to small areas (0.03 – 1ha) according to species specific guidance.
Young stand	< 4	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings if regeneration is sparse.
Thicket stage	6 – 10	• Maintain closed canopy in groups of dense natural regeneration, except for WCH. Negative selective respacing only – removal of wolf trees (BE) and other undesirable individuals. • Start pruning of promising FC tree candidates where self-pruning cannot be achieved (*i.e.* in WCH or wide spacing scenarios).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise shift focus to positive selection – carefully promote up to 250 FC tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process. Continue pruning WCH.
Pole to small timber stage	16 – 18	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 130 FC trees/ha (preferably XBLL), and crown thin to release their crowns from competitive neighbours. A slightly clumped occurrence of FC trees is acceptable with BE and SY. • Retain sub-dominant and suppressed trees to develop a diverse stand structure.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop the understorey in order to suppress epicormic growth (SY) and to control ground vegetation. Prevent understorey trees from encroaching into the crown area of FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Selectively harvest FC trees as they reach target DBH. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

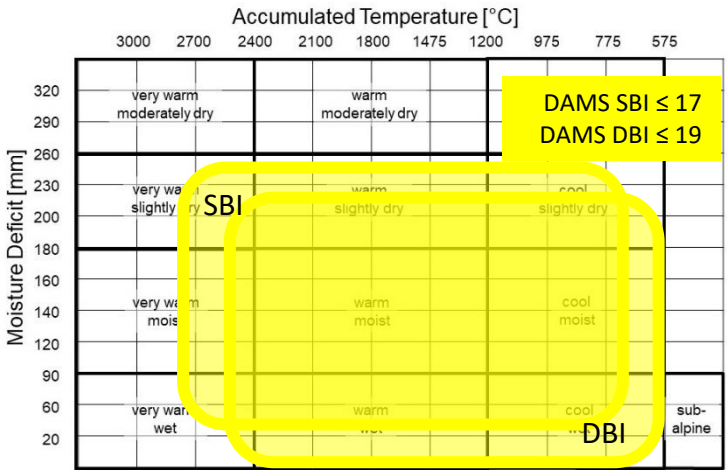
FDT 7.1.1 BI

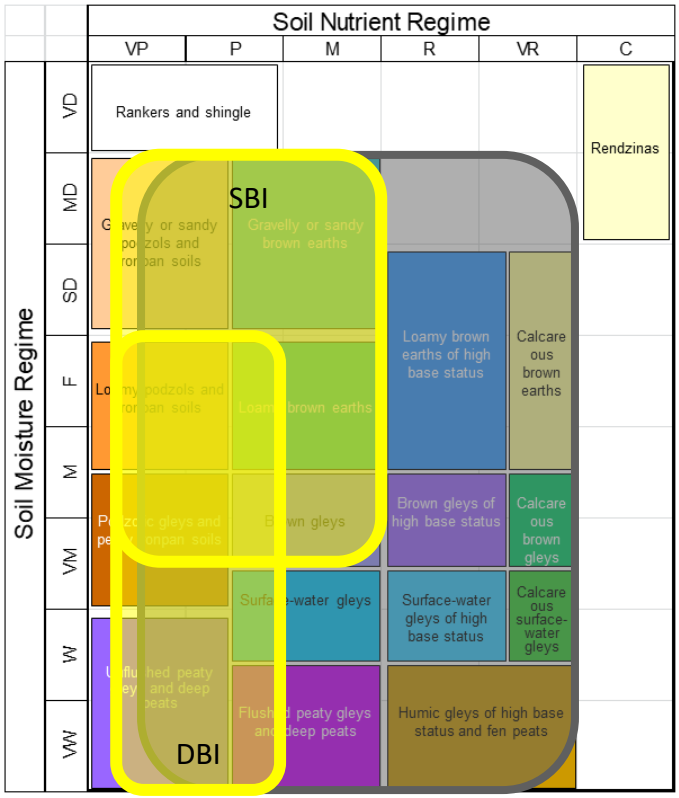


1. Structure and dynamics:
Generally single-storeyed stand of dominating BI interspersed with category A minor species according to site conditions including AR, WIL, ROW, ASP, OK and conifers.
Species distribution: BI 70 – 100% minor species: < 30%
Depending on management objectives these stands could either be maintained by clearfell-and-restock or LIMA regimes using natural regeneration. They could also be considered as a transition stage for successor stands of more exacting species, which will be introduced by underplanting.



2. Ecological suitability:
This FDT includes NVC type W4 but also represents early succession stages of various other NVC types. Generally suitable for soils of poor and very poor fertility over a wide moisture range. SBI is preferable on drier soils and slightly more fertile sites whereas DBI is the better choice on wet and peaty soils. Both species are frost hardy pioneer species and soil improvers and the FDT is therefore suitable for problem sites.





3. Management objectives:

Economic:	logs / pulp / biomass (optional)
Environmental and social:	Important as habitats, nurse crops, for water quality, soil conservation and site improvement. High landscape and amenity value due to open character and autumn colours.

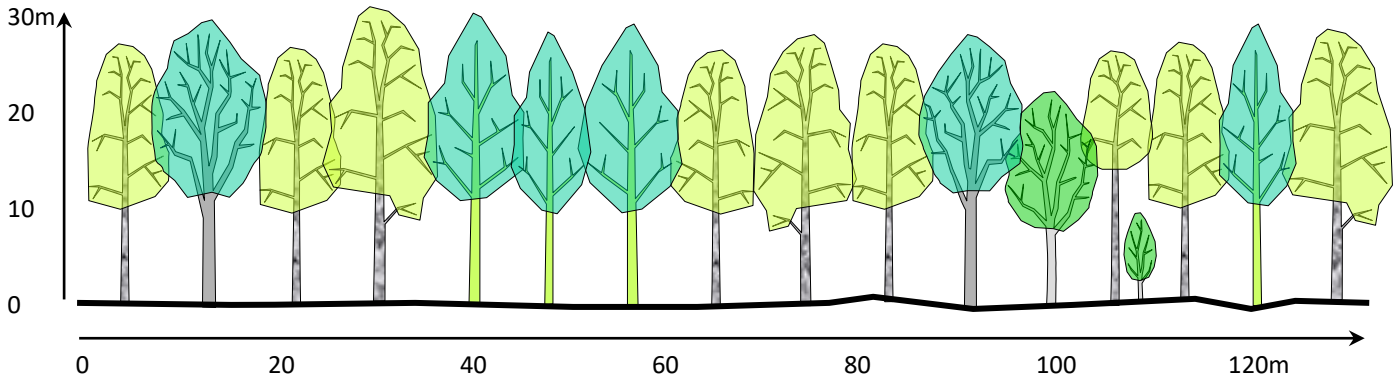
4. General management principles for the FDT

This FDT is for even-aged stands on sites where BI is strongly dominant and meets management objectives. It also includes scenarios where BI is used as an interim solution and is underplanted with other species, leading to a different FDT. Due to their growth pattern and relatively short life expectancy the Q/D approach is not applicable to BI. Management of young stands should aim to achieve rapid growth and, where applicable, timber quality. A no thinning approach is possible but will limit management options and achievable target DBH. The growth rate of BI peaks very early in life and diminishes rapidly thereafter; respacing and thinning must therefore focus on thicket, pole and small timber stage if sawlog dimensions are to be achieved. Respacing of dense natural regeneration must ensure a live crown length of > 60% of tree height is maintained at all times in dominant trees. Thinning should start at 10 – 12m top height, generally as crown thinning. Thinning at later stages should aim to maintain an even canopy cover and steady growth. Clearfell-and-restock is the main management scenario envisaged. On most sites BI reproduces easily; opportunities for natural regeneration should therefore be used unless undesirable for timber quality reasons.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 3000 seedlings/ha, planting of 2000 – 3000 trees/ha, or direct seeding.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if thinning is envisaged and N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access to 800 – 1200 trees/ha. • Promotion of minor species as required.
Thicket stage	4 – 8	• Generally no interventions, except where respacing in the previous stage has been missed and thinning is envisaged or live crown ratio of dominant trees drops to < 60%. In this case reduce N to 800 – 1500 trees/ha, favouring SBI over DBI and seed-grown trees over coppice.
Pole stage	10 – 12	• Selection of 200 – 300 FC trees/ha (optional), consider pruning of high quality individuals on most productive sites. • First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. Thinning should achieve gaps of > 1m between crowns of adjacent trees.
Pole to small timber stage	12 – 20	• Monitor canopy cover and repeat thinning when gaps close. • Focus on competition status of FC trees (if applicable). • In transition scenarios, establish successor stand by underplanting.
Timber stage		• Monitor stand density, timber quality and health, and thin accordingly. Reduce thinning intensity and / or lengthen thinning cycles as BI becomes less responsive to thinning. • Plan for final harvesting when BI approaches the end of its natural life time or target DBH, or when successor stand no longer requires protection.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

FDT 7.1.2 BI and short-lived broadleaves (XBSL)



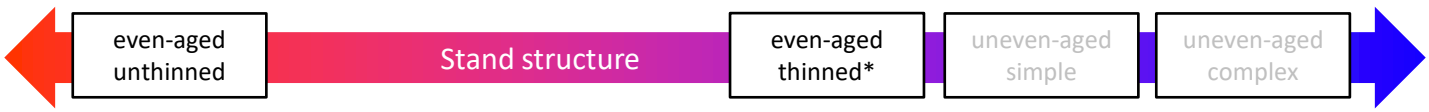
1. Structure and dynamics:

Generally single-storey stands dominated by BI birch with a high proportion of native XBSL such as ASP, ROW, WIL and category C minor species. Mixture type may vary from individual trees to small areas.

Species distribution: BI 50 – 70% XBSL 30 – 50% minor species: 10 – 30%

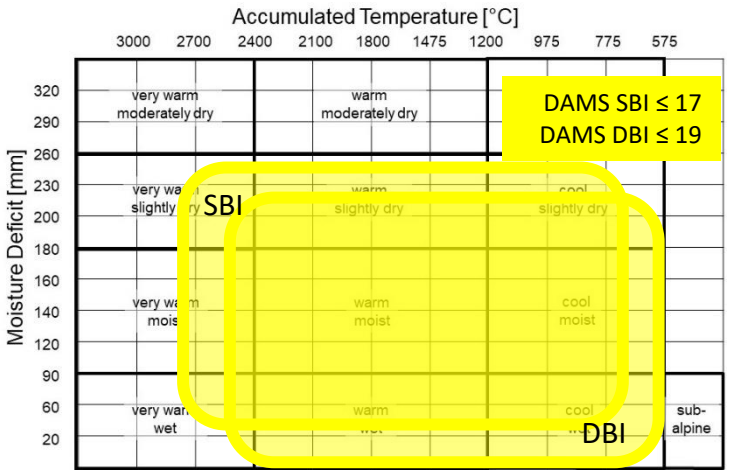
This FDT often results naturally from pioneer species colonising sites with variable soil conditions.

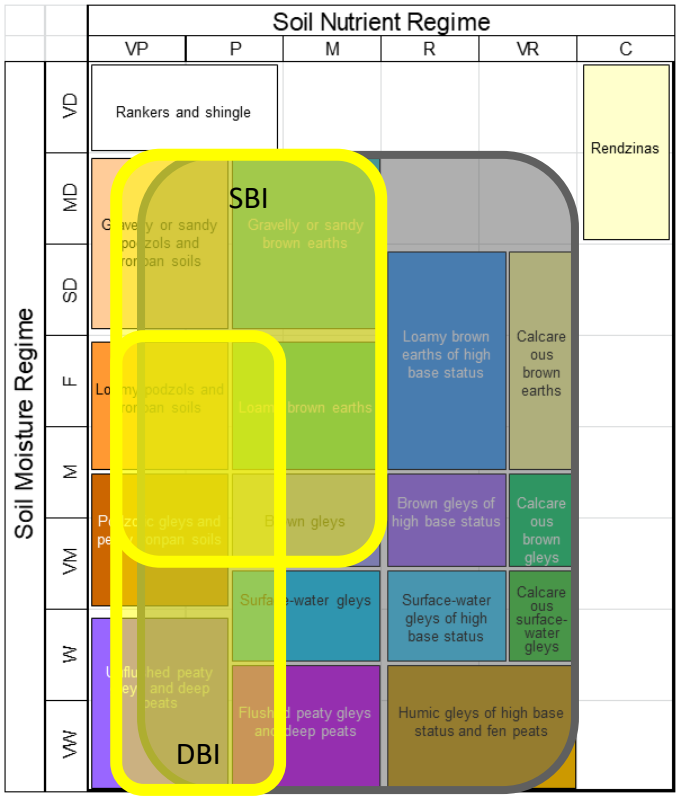
Management will usually be low input and use natural regeneration as the main restocking method.



2. Ecological suitability:

Represents NVC type W4 where XBSL occupy microsites less suitable for BI. Soils are generally poor and acidic but can be highly varied with regard moisture and texture, including peatlands. The soil improving nature of the pioneer species involved makes this FDT suitable for problem sites.





3. Management objectives:

Economic:	logs / pulp / biomass (optional)
Environmental and social:	High environmental value as habitats, for water retention and soil conservation / improvement. The mixed and natural character of the stands is likely to be attractive for amenity and recreation.

FDT 7.1.2 BI and short-lived broadleaves (XBSL)

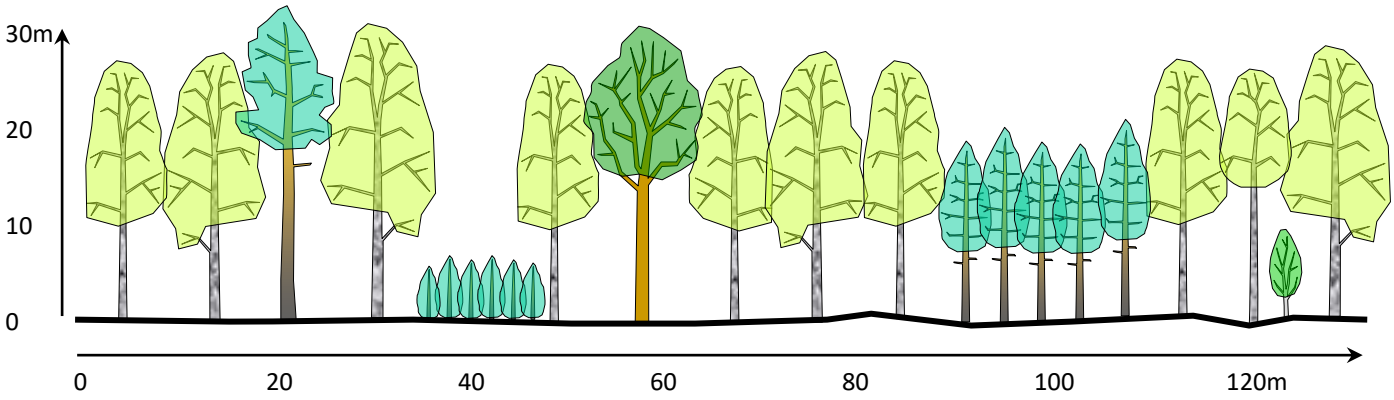
4. General management principles for the FDT

This FDT is for even-aged stands of BI supplemented by a considerable proportion of native XBSL. Due to their growth pattern and relatively short life expectancy the Q/D approach is not applicable to BI and XBSL. Both components are quite compatible to grow in mixture (CS = 1 or 2). Management of young stands should aim to achieve rapid growth and, where applicable, timber quality. A no thinning approach is possible but will limit management options and achievable target DBH. Growth rates of BI and XBSL peak early in life and diminish rapidly thereafter; respacing and thinning must therefore focus on thicket, pole and small timber stage if sawlog dimensions are to be achieved. Respacing of dense natural regeneration should be used to steer species composition. Thinning should start at 10 – 12m top height, generally as crown thinning. Thinning at later stages should aim to maintain an even canopy cover and steady growth. Clearfell-and-restock or LIMA are the main management scenarios envisaged. On most sites BI and XBSL reproduce easily; opportunities for natural regeneration should therefore be used unless undesirable for timber quality reasons.

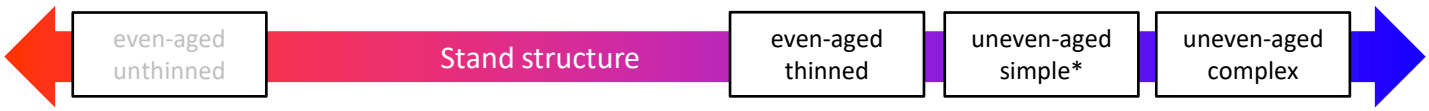
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 3000 seedlings/ha, planting of 2000 – 3000 trees/ha, or direct seeding.
Young stand	< 3	• Protection against animals / plants as necessary. • Respacing if thinning is envisaged and N > 3000 trees/ha at 1 – 2m tree height. Reduce N to 1500 – 2500 trees/ha; in areas of difficult access to 800 – 1200 trees/ha. • Steering of BI / XBSL proportion in natural regeneration, promotion of minor species as required.
Thicket stage	4 – 8	• Generally no interventions, except where respacing in the previous stage has been missed and thinning is envisaged or live crown ratio of dominant trees drops to < 60%. In this case reduce N to 800 – 1500 trees/ha, favouring SBI over DBI and seed-grown trees over coppice.
Pole stage	10 – 12	• Selection of 200 – 300 FC trees/ha (optional), consider pruning of high quality individuals on most productive sites. • First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. Thinning should achieve gaps of > 1m between crowns of adjacent trees.
Pole to small timber stage	12 – 20	• Monitor canopy cover and repeat thinning when gaps close. • Focus on competition status of FC trees (if applicable).
Timber stage		• Monitor stand density, timber quality and health, and thin accordingly. Reduce thinning intensity and / or lengthen thinning cycles as BI / XBSL become less responsive to thinning. • Plan for final harvesting when BI / XBSL approach the end of their life time or target DBH. • Assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method.

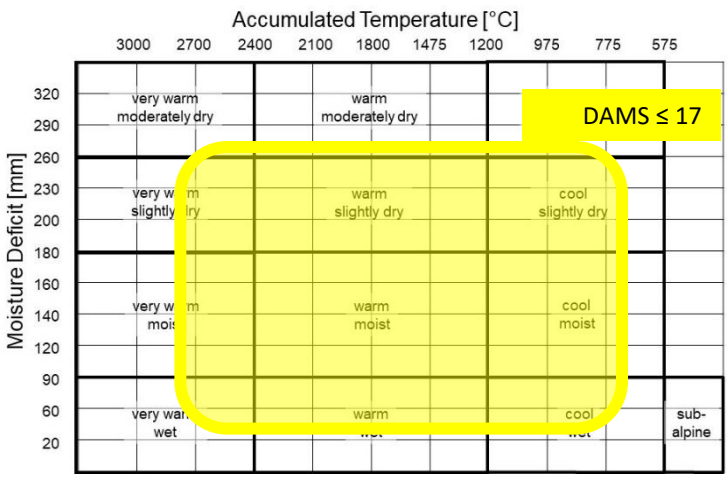
FDT 7.2.1 SBI and SP

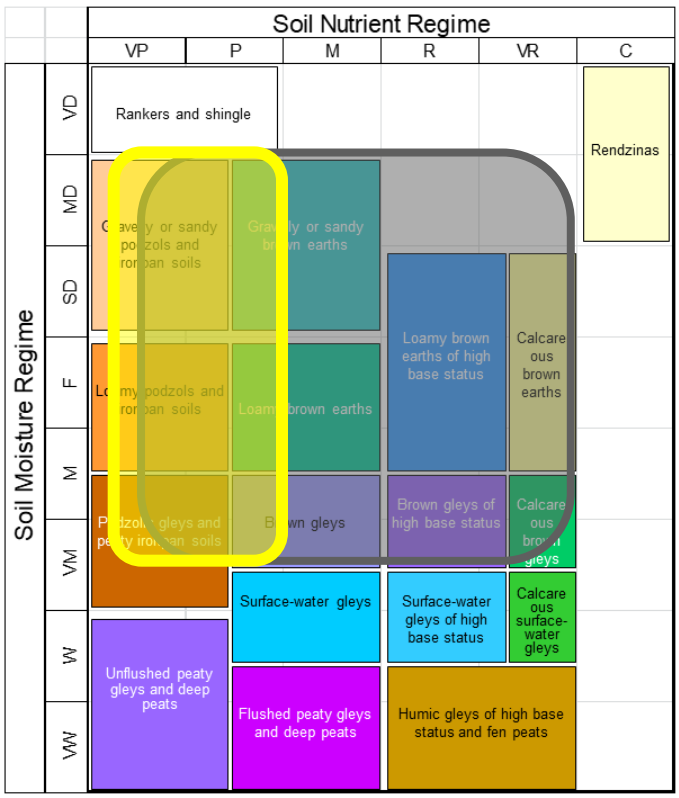


1. Structure and dynamics:
Mosaic of single-storeyed SBI intermingled with individual trees to small areas of SP of variable age and category C minor species, particularly OK.
Species distribution: SBI 60 – 90% SP: 10 – 40% minor species: < 20%
SBI and SP will be managed using LIMA with single species cohorts on different rotations. SP and OK may be planted if regeneration is insufficient; BI and minor species should propagate via natural regeneration.



2. Ecological suitability:
Contains important elements of NVC types W4, W18 and W17 or W16 in the upland and lowland climate zone. This FDT belongs on nutrient poor soils with sandy to sandy loam texture and low to intermediate water supply.





3. Management objectives:

Economic: SBI – sawlogs, target DBH > 30cm in 60 – 80yrs (optional)
SP – sawlogs, target DBH > 40cm in 100 – 140yrs

Environmental and social: These stands can be very important for habitat quality and, in conifer dominated landscapes in the uplands, help to improve soil fertility as well as increase forest and landscape scale diversity. Attractive forests due to open character and autumn colours.

4. General management principles for the FDT

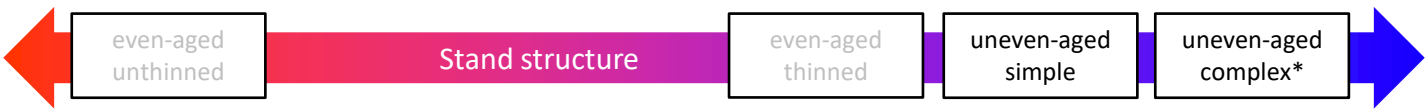
This FDT is for productive SBI / SP stands on low fertility sites where structural and species diversity is desirable and both species show good potential to regenerate naturally (comparable to FDT 2.1.7 but with inverse species proportions). As pioneer species SBI and SP are quite compatible (CS = 2) to grow in mixtures, with growth rates peaking early in life and diminishing rapidly thereafter. Due to its growth pattern and relatively short life expectancy the Q/D approach is not applicable to SBI. If SBI is to be grown to sawlog dimensions respacing and thinning must ensure that the relative length of the live crown never drops below 60% of tree height. Timber quality in SP is more variable than in other conifers; therefore high initial density is desirable to provide scope for quality selection during respacing and thinning. Thinning should start at around 10 – 14m top height, generally as crown thinning, and focus on pole and small timber stage. Thinning at later stages must aim to maintain steady growth and tree stability. BI will likely be managed on a shorter rotation than SP; LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

5. Timeline

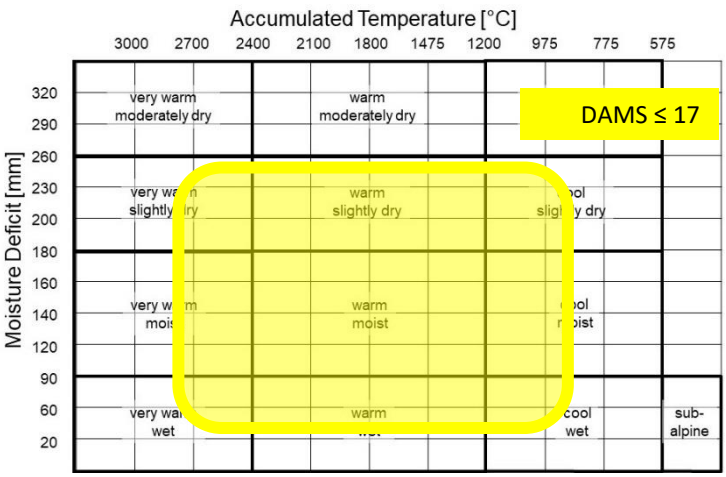
stage	H_{100} [m]	intervention
Establishment		• SBI: Planting of 2000 – 3000 trees/ha or natural regeneration. • SP: Planting of 3000 – 8000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • SBI: Systematic respacing to 1500 – 2500 trees/ha (800 – 1200 trees/ha in areas of difficult access) if N > 3000 trees/ha at 1 – 2m tree height. • SP: Negative selective respacing (removal of wolf tree candidates). • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	4 – 10	• Generally no interventions, except for: • Systematic (SBI) / negative selective (SP) respacing and careful promotion of 400 – 600 FC tree candidates/ha if respacing in the previous stage has been missed.
Pole stage	10 – 14	• Selection of 200 – 300 FC trees/ha (SBI + SP), consider pruning of high quality individuals on most productive sites. • First selective crown thinning, mainly removing dominant / co-dominant trees with visible defects, coarse branching or poor shape. Thinning should achieve gaps of > 1m around crowns of SBI FC trees.
Pole to small timber stage	14 – 20	• Focus on competition status of FC trees – repeat crown thinning when canopy gaps close. Monitor competition between SBI and SP and adjust thinning to maintain target species composition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. Reduce thinning intensity and / or lengthen thinning cycles as SBI / SP become less responsive to thinning. • Plan for final harvesting when FC trees approach target DBH. • Decide on LIMA / CCF methods to be used and assess potential for natural regeneration – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting / restocking operations according to agreed method. • Follow species specific guidance for SBI / SP dominated components. • Monitor light level, ground vegetation conditions, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

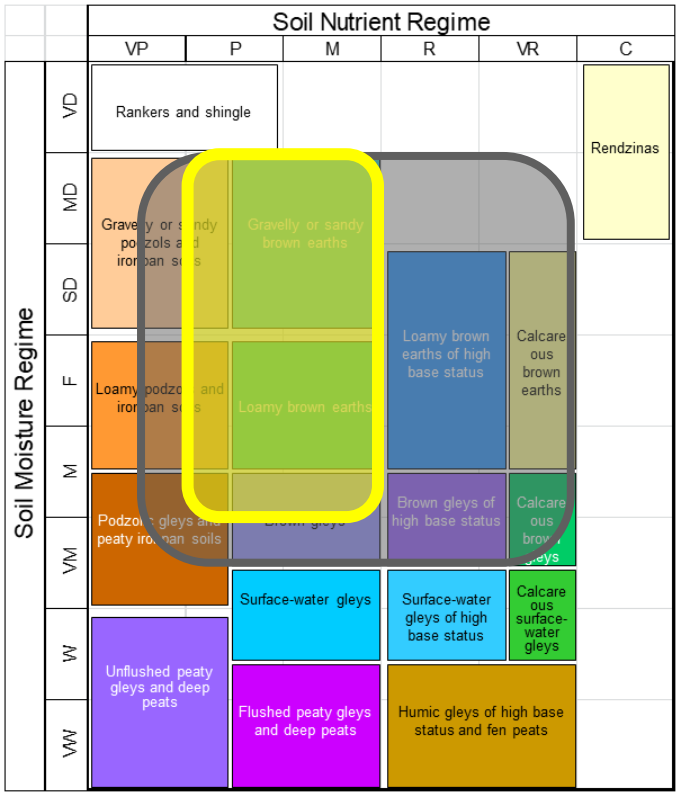
FDT 7.2.2 SBI and SOK

1. Structure and dynamics:
Single to multiple-storeyed stand dominated by SBI with a significant proportion of SOK in individual tree to small area mixture. Category C minor species such as SP, ASP, ROW, BE and others according to site conditions.
Species distribution: SBI 50 – 80% SOK 20 – 50% minor species: < 30%
Stands may be managed LIMA or CCF regimes, aiming to develop and maintain a diverse stand structure. SOK is likely to require planting but SBI and minor species should regenerate naturally.



2. Ecological suitability:
This FDT represents successional stage of NVC types W11, W16, W15 and W17 of the lowland and upland climatic zones. Suitable for sandy to loamy soils of poor to medium fertility where SBI performs well (GYC > 6) and SOK is also a viable option. Similar to FDT 5.2.1 but with reversed proportions of BI and OK.





3. Management objectives:

Economic (SBI GYC > 6):	SBI – sawlogs, target DBH > 40cm in 60 – 80yrs
	OK – sawlogs, target DBH > 50cm in 120 – 180yrs
Environmental and social:	Diverse woodland of natural appearance and high conservation value. Presence of deadwood, veteran trees and habitats for light demanding species. Attractive to visitors because of its open structure and diversity.

FDT 7.2.2 SBI and SOK

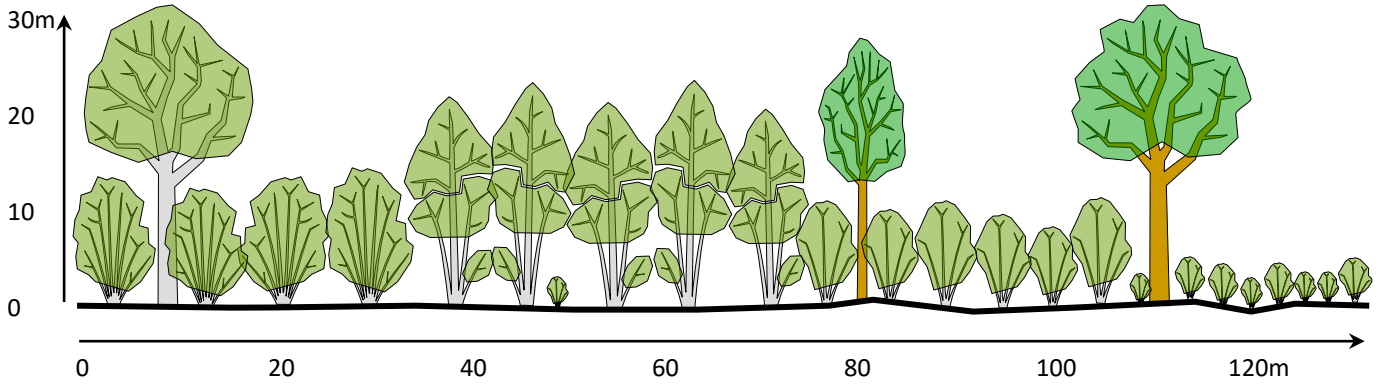
4. General management principles for the FDT

This FDT is comparable to FDT 5.2.1 but with inverse species proportions. Compatibility of SBI and SOK to grow in mixture is only moderate (CS = 3); therefore (and for timber quality) spatial separation in groups to small areas will be preferable. Growth pattern and relatively short life expectancy of SBI dictate that respacing and thinning must focus on thicket to small timber stage in order to achieve sawlog dimensions. In contrast, SOK responds well to thinning interventions throughout its lifetime and the Q/D management approach with high initial stocking density may be used provided sawlog production is a viable option. As a typical pioneer species SBI will outgrow SOK at young age but lose its competitive advantage later, thinning interventions will have to be adapted with regard to tree species and time. Crown thinning should be applied throughout for both species, starting at 10 – 14m top height in BI and 16 – 18m in SOK. BI will be managed on a much shorter rotation than SOK and the FDT may have to be reviewed at this stage. LIMA / CCF methods should be used to maintain the desired horizontal and vertical stand structure.

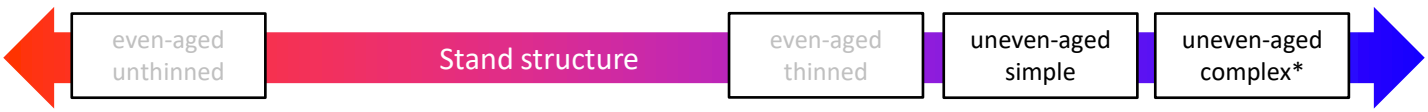
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Natural regeneration in densities of > 10000 seedlings/ha or planting of 2000 (SBI) – 5000 (SOK) trees/ha. Most commonly SOK may be established in clusters (20 – 30 plants at 0.3 – 1m spacing) and BI recruited from natural infill.
Young stand	< 3	• Protection against animals / plants as necessary. • SBI: Systematic respacing to 1500 – 2500 trees/ha (800 – 1200 trees/ha in areas of difficult access) if N > 3000 trees/ha at 1 – 2m tree height. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• SBI: Cleaning or pollarding of aggressive SBI overtopping promising SOK. Systematic respacing to about 800 – 1200 trees/ha if respacing in previous stage has been missed. • SOK: Negative selective respacing (removal of undesirable individuals).
Pole stage	10 – 14	• SBI: Select 200 – 300 FC trees/ha and thin to achieve gaps of > 1m around crowns of SBI FC trees. • SOK: Selective respacing as necessary (refer to FDT 5.2.1). Maintain closed canopy for ongoing self-pruning and differentiation.
Pole to small timber stage	16 – 18	• SBI: Focus on competition status of FC trees – repeat crown thinning when canopy gaps close. Monitor competition between SBI and SOK and adjust thinning to maintain target species composition. • SOK: Select 80 – 100 FC trees/ha when the desired length of clean bole has been reached and apply crown thinning to release from competition.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees, ensuring live crown ratio remains at > 60% of tree height. • Assess potential for natural regeneration and decide on harvesting method when SBI approaches target DBH; improve conditions if necessary. • Monitor occurrence and growth rate of SBI regeneration, review FDT and / or supplement by planting if necessary.
Final harvesting and regeneration stage		• Time final harvesting operations in SOK with mast years if possible. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary, or restock.

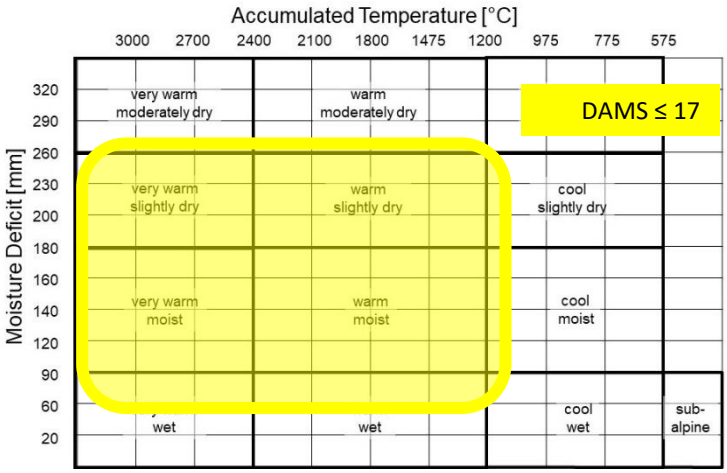
FDT 8.1.1 SC coppice

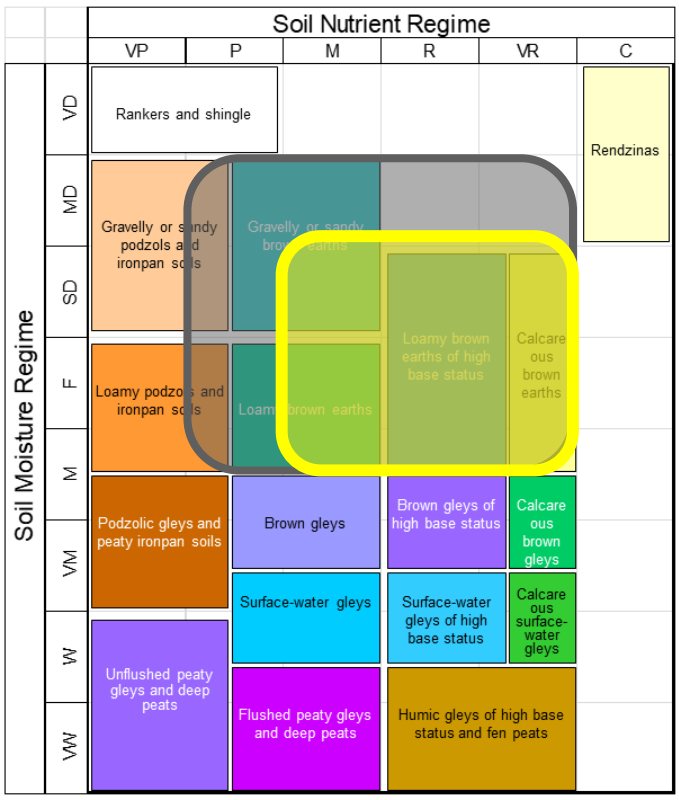


1. Structure and dynamics:
Two to multiple storeyed stand of SC where the majority of trees are *actively* managed using either a simple coppice or a coppice-with-standards system. Supplemented by category C minor species in single tree mixture.
Species distribution: SC 80 – 100% minor species: < 20%
Periodic replacement of old stools after several coppice rotations by planting or layering will be required.



2. Ecological suitability:
Contains elements of NVC types W10 and W8 in the lowland climate zone. Suitable for deep, well aerated soils with at least average nutrient supply. Short rotation coppice on poor soils should be avoided due to nutrient depletion. Exposed sites and frost hollows are also unsuitable.





3. Management objectives:

Economic:	logs / fencing material / biomass in 10 – 70yrs
Environmental and social:	High environmental value for maintaining coppice-specific habitats for flora and fauna. Attractive to visitors due to interesting stand structure, spring and autumn aspects. Cultural value as historic forest management system. Use of chestnuts as non-timber forest product.

4. General management principles for the FDT

Coppice has a long history as a forest management system and SC is one of the most suitable and versatile species for this purpose. This FDT is designed for scenarios where SC is predominantly managed by coppicing, including coppice with standards. The latter often involves other XBLL (namely OK) but as the standards are grown over several SC coppice rotations species compatibility is irrelevant. Due to the high number of shoots SC coppice may be managed using the Q/D method. SC retains its ability to coppice from stools for about 100yrs, older stools will therefore have to be replaced by planting or layering. The rotation length will depend on the envisaged final product, ranging from 2 – 3a for walking sticks, 5 – 7a for bean poles, 12 – 20yrs for fencing posts to 50 – 70yrs for sawlogs. The Timeline below is based on the assumption that all of the above form part of the management objectives; if only certain products are targeted management will have to be adjusted accordingly. Coppice systems are usually operated at a small scale (0.3 – 0.5ha) by sequential cutting of coupes, leading to a more varied horizontal and vertical stand structure.

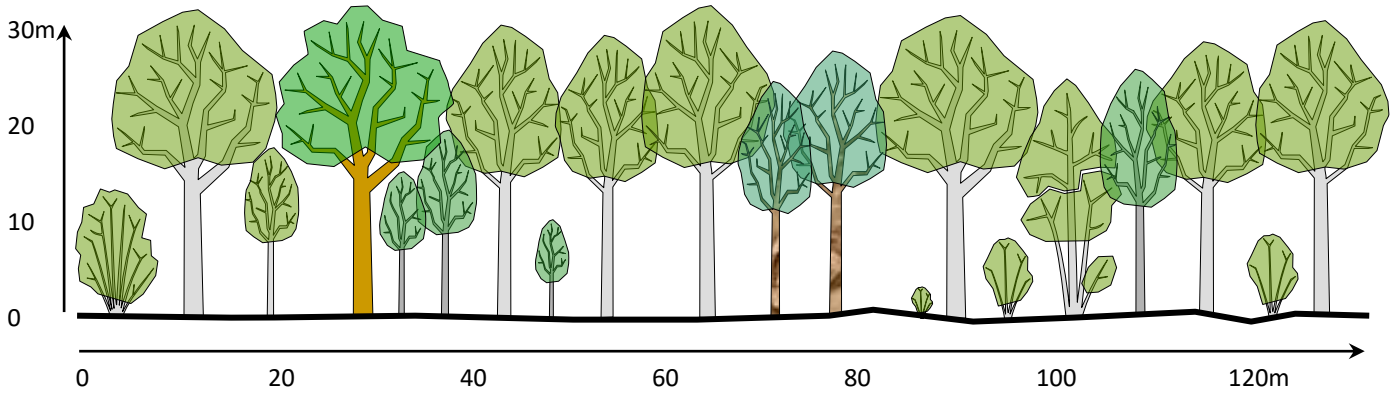
5. Timeline

stage	H_{100} [m]	intervention

Establishment		• Density of coppice stools depends on the envisaged main end product:
		  • 1500 – 2000 ha^{-1} for walking sticks, wicker work and bean poles;
		  • 800 – 1000 ha^{-1} for fencing posts, poles, paling material;
		  • 200 – 500 ha^{-1} for sawlogs.
		• Protection against browsing by mammals as coppice shoots are particularly vulnerable.
		• New stools are created by planting or layering.
		• In coppice with standards systems: Planting of XBLL according to species specific guidance.

Young stand	2 – 5	• Harvesting of small dimension SC products (walking sticks etc.). • Regulation of species composition and minor species as required. • XBLL standards: Formative pruning if required.
Thicket stage	5 – 10	• Generally no interventions except for regulating competition between XBLL standards ad SC coppice where required.
Pole stage	10 – 18	• Harvesting of medium dimension SC products (fencing material etc.). • Retain the best quality shoot per stool to grow into sawlog dimensions, select 150 – 300 FC trees/ha and consider pruning if appropriate. • XBLL standards: Apply crown thinning to release from competition, consider pruning.
Timber stage		• Monitor species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. • Manage re-growth from coppice stools to develop understorey. • Plan for final harvesting when FC trees approach target DBH. • XBLL standards may be managed on several SC coppice rotations.
Final harvesting and regeneration stage		• Harvest SC FC trees as they reach target DBH. • Supplement SC coppice stools by new planting or layering as necessary.

FDT 8.1.2 SC and long-lived broadleaves (XBLL)

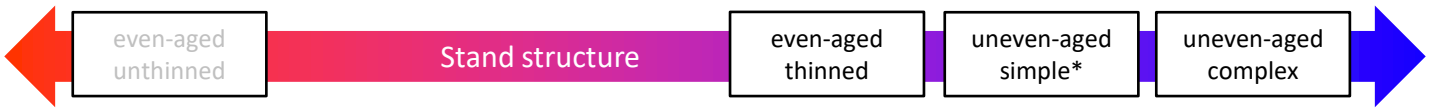


1. Structure and dynamics:

Single to multiple storeyed stand of dominating SC and XBLL such as OK, BE, SY and other species in single tree to large area mixture. Supplemented by a wide variety of category B minor species.

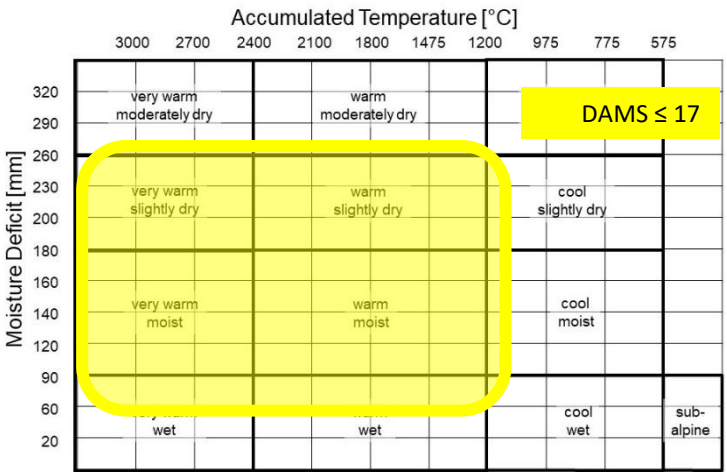
Species distribution: SC 50 – 80% XBLL 20 – 50% minor species: < 20%

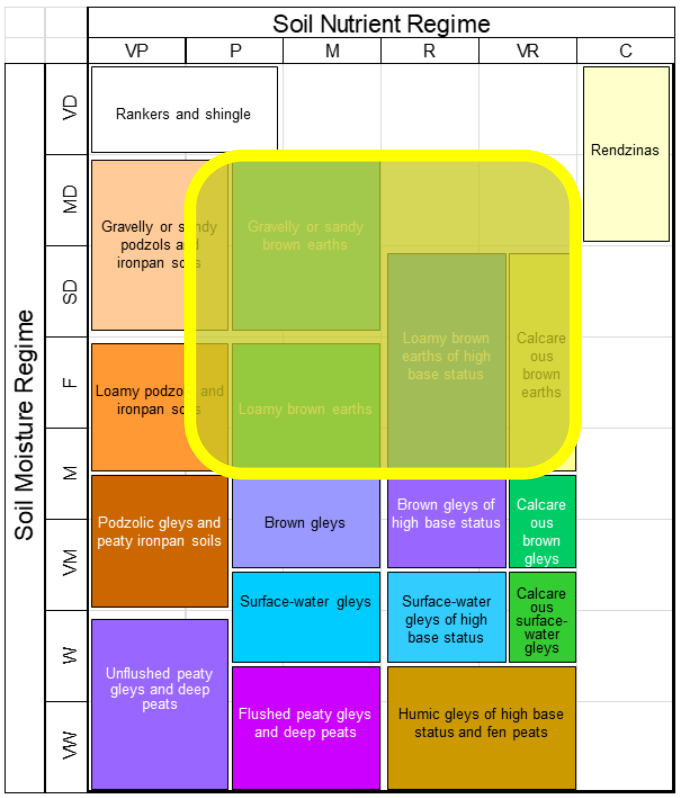
Stand management options are wide and include clearfell-and-restock, LIMA and CCF regimes as well as coppice. Management towards a diverse stand structure is preferable and natural regeneration should be used wherever possible.



2. Ecological suitability:

This FDT contains elements of NVC types W8, W10, W14 and W15 in the lowland climate zone. Suitable for deep, fertile and well aerated soils of sandy to loamy texture. Exposed sites and frost hollows should be avoided.





3. Management objectives:

Economic:	SC – logs / fencing material / biomass in 10 – 80yrs XBLL – sawlogs / pulp / fuel
Environmental and social:	Diverse woodland of natural appearance and high conservation value. XBLL elements add productivity, improve timber quality and control ground vegetation. Attractive to visitors because of its diverse structure and tree size. Use of chestnuts as non-timber forest product.

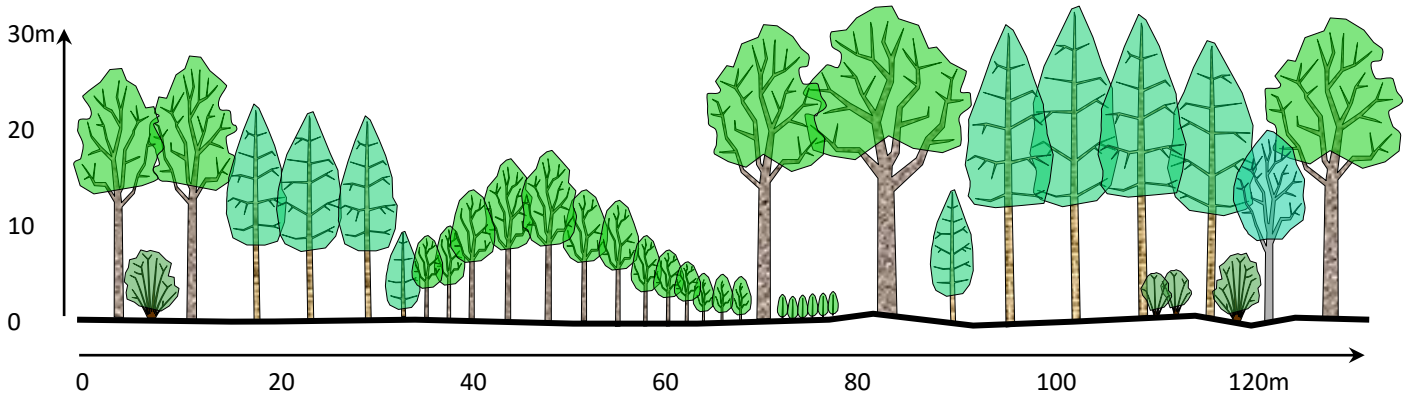
4. General management principles for the FDT

This FDT is for SC predominantly managed as high forest, although a certain amount of coppicing may be included. In contrast to SC coppice systems this FDT should be managed using the Free Growth method. The FDT is suitable for a wide range of soil fertility; as a general rule the better the soil fertility is the higher the proportion of XBLL and the more complex the stand structure should be. Mixture compatibility between SC and XBLL will vary depending on species (CS = 1 for OK and BE, CS = 2 for WCH and LI, CS = 4 for SY); less competitive species require more support by interventions and will generally benefit from being established in groups rather than intimate mixture. In multiple storey stands SC and light demanding XBLL should dominate the overstorey whereas shade tolerant XBLL are mostly confined to the middle and understorey. The inherently high risk of ring shake in SC can be reduced by achieving consistently wide growth rings (> 4mm), therefore frequent thinning is essential for achieving timber quality. Depending on species and spacing, clean boles in FC trees may be achieved by artificial pruning (SC) or Q/D approach (XBLL). LIMA / CCF methods should be the preferable option for final harvesting / restocking, diversifying the stand structure further.

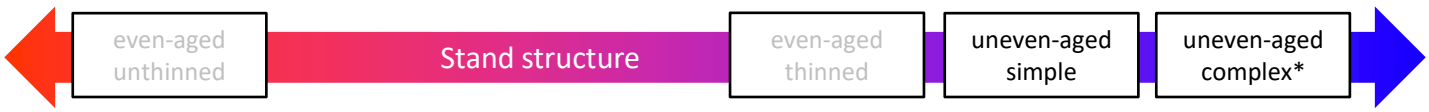
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• SC: Planting of 2000 – 3000 trees/ha, coppicing, or natural regeneration. • XBLL: Natural regeneration or planting according to species specific guidance. Shade tolerant XBLL may be also introduced by underplanting at a later stage.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings where necessary.
Thicket stage	6 – 10	• Monitoring of growth rate, development of timber quality and species composition, interventions if necessary.
Pole stage	12 – 16	• SC: Select 80 – 150 FC trees/ha and apply crown thinning to release from competition. Single stems originating from coppice stools. Favour seed-grown trees over coppice. Consider pruning of FC trees to achieve desired length of clean bole. • XBLL: Follow species specific guidance for high or low density scenarios.
Pole to small timber stage	16 – 20	• SC: Monitor competition status of FC trees and continue crown thinning and pruning. • XBLL: Follow species specific guidance. • Retain sub-dominant and suppressed trees to develop a diverse stand structure, consider underplanting if understorey is absent.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop the understorey in order to suppress epicormic growth and to control ground vegetation. Prevent understorey trees from encroaching into the crown area of FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by coppicing / planting if necessary.

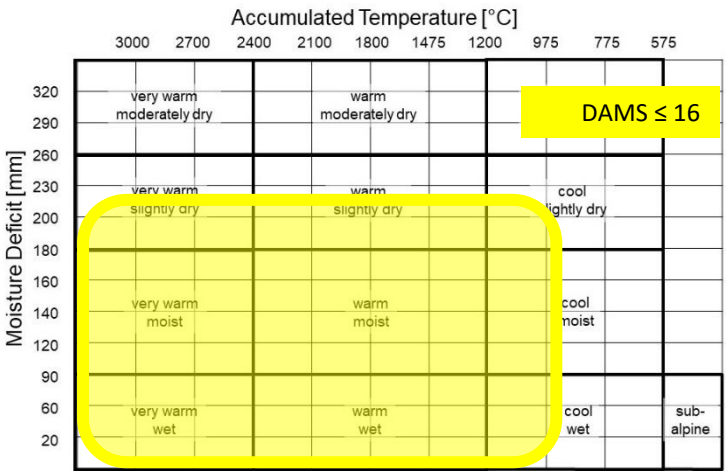
FDT 8.2.1 AH and CAR

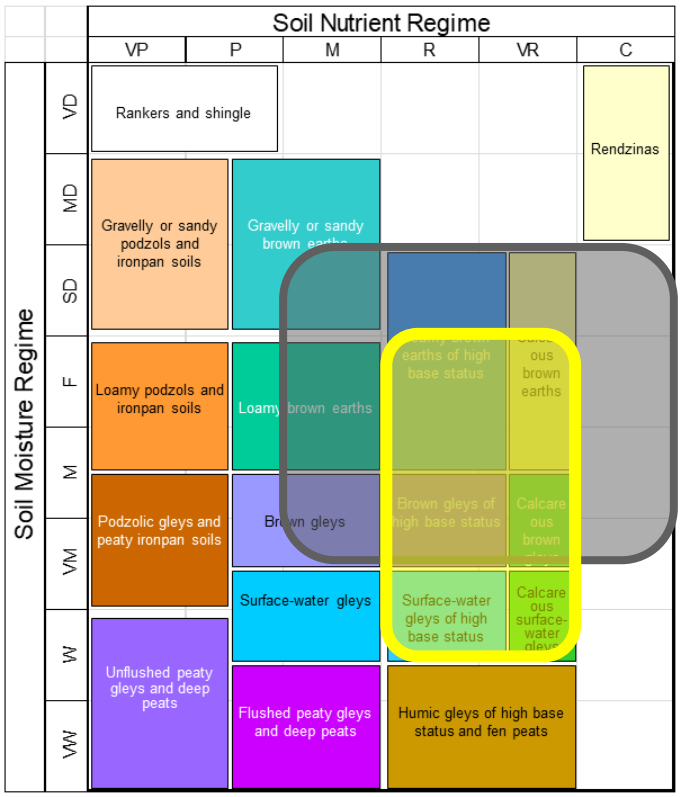


1. Structure and dynamics:
Mosaic of single-storeyed small groups to patches of AH and CAR of variable age, with BI, OK, ASP, WIL, BCH, ROW and other species as category C minor components. Species mixture pattern will mirror soil moisture distribution, with AH dominating the fresh, and CAR the wet end of the range. A distinct shrub layer is often present.
Species distribution: AH 50 – 70% CAR: 30 – 50% minor species: < 10%
AH and CAR will be managed in single cohorts on different rotations, simulating the gap dynamics of natural forests. AH and minor species should propagate via natural regeneration.



2. Ecological suitability:
Represents NVC type W7 and overlaps with W2, W5 and W6. This FDT belongs on nutrient rich loamy soils with variable but generally above average water supply. Suitable for both upland and lowland climate but frost hollows are to be avoided.





3. Management objectives:

Economic:	AH – sawlogs, target DBH > 60cm in 80 – 100yrs
	CAR – sawlogs, target DBH > 40cm in 60 – 100yrs
Environmental and social:	Woodland of natural appearance, providing diverse habitats including veteran trees and deadwood. High value for water quality management in wetlands and riparian zones. CAR acting as soil improver.

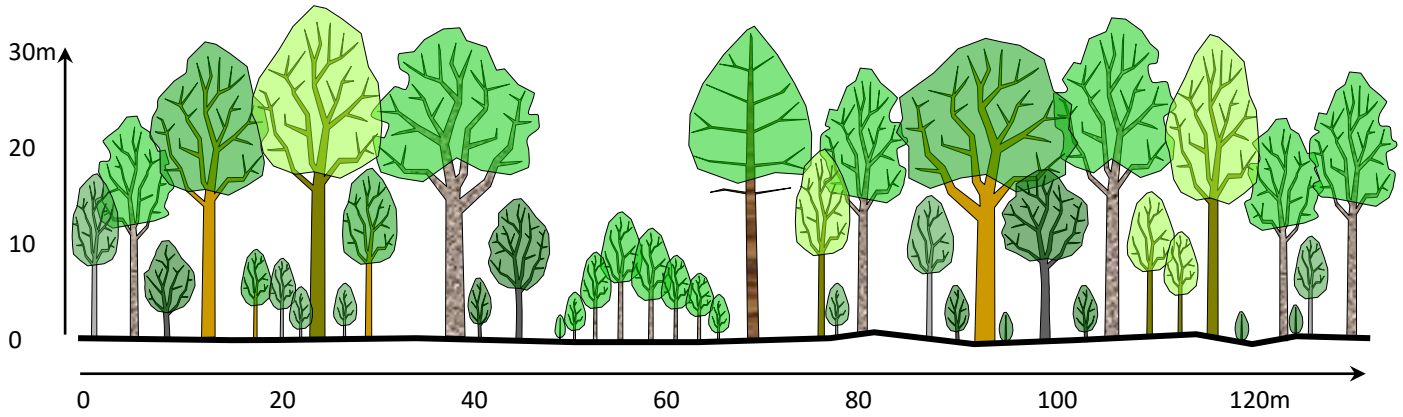
4. General management principles for the FDT

Due to their specific growth rates and light demand AH and CAR are generally not compatible (CS = 4) to grow in intimate mixtures and should therefore be separated by microsite conditions (SMR; CAR occupying the wetter areas of the site). Timber quality of both species benefits from moderate to high initial stocking density and requires careful quality selection during respacing and thinning. Dominant trees of poor quality need to be eliminated by selective respacing, desirable FC trees promoted by thinning. The growth response to thinning interventions in both species is strong at young age but fades quickly later; the Q/D management approach must therefore ensure the crowns of FC trees are fully developed at an age of about 40yrs. Crown thinning should be applied throughout. Thinning at later stages must aim to maintain steady growth of FC trees. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure. Depending on the effects of ash dieback the choice of FDT may have to be reviewed.

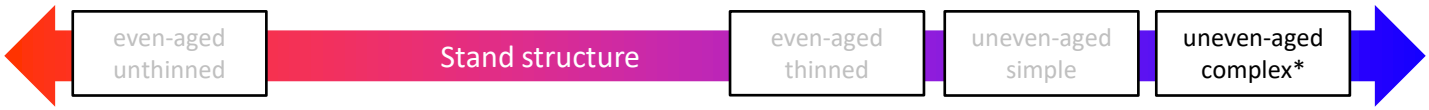
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 5000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), clearing of damage caused by felling / extraction of overstorey trees, and cleaning or pollarding of aggressive infill overtopping promising AH and CAR.
Pole stage	8 – 12	• Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 3 competitor(s) including whips causing mechanical damage. Maintain closed canopy for ongoing self-pruning, consider artificial pruning in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 120 (AH + CAR) FC trees/ha, and apply crown thinning to release their crowns from competitive neighbours including sub-dominant trees causing mechanical damage (whips).
Timber stage		• Monitor competition status of FC trees, species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees; crowns of FC trees must remain completely free from contact with neighbouring trees. • Maintain and develop understorey where present. • Assess potential for natural regeneration and decide on harvesting method when FC trees approach target DBH – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by coppicing (CAR) / planting if necessary.

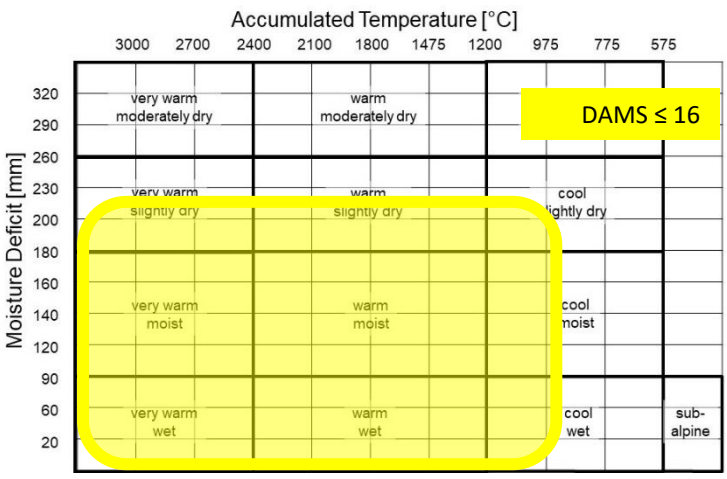
FDT 8.2.2 AH and long-lived broadleaves (XBLL)

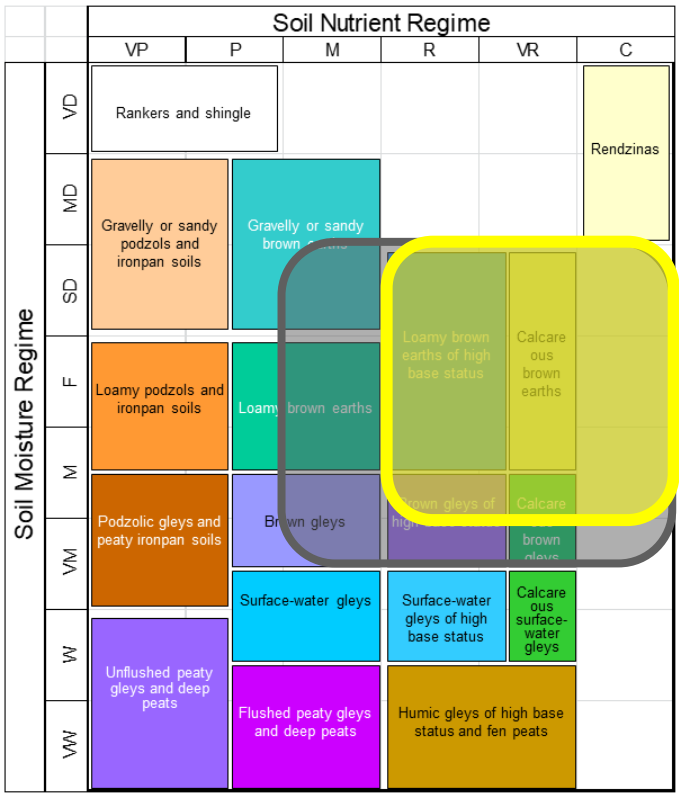


1. Structure and dynamics:
Multiple storeyed stand of AH and substantial proportions of SY, OK, LLI, WCH, WST and others in single tree to group mixture. The middle and understorey are dominated by HBM, BE, SY, NOM, FM; category C minor components are present according to site conditions.
Species distribution: AH 50 – 70% XBLL: 30 – 50% minor species: 20 – 40%
Management under CCF regimes must aim to maintain the diverse structure by simulating the gap dynamics of natural forests. Most species should propagate via natural regeneration, supplementary planting where necessary.



2. Ecological suitability:
Resembles NVC types W8, W9, W10 and W11, or earlier succession stages of W12 and W14; may contain elements of W13 on carbonate soils. Suitable for drier soils with above average nutrient supply including calcareous types, in upland and lowland climate zones alike.





3. Management objectives:

Economic:	AH – sawlogs, target DBH > 50cm in 80 – 120yrs XBLL – veneer / joinery grade / logs / pulp / biomass
Environmental and social:	Attractive woodland of natural appearance and high diversity , providing a range of habitats including veteran trees and deadwood. High amenity and recreation value through spring and autumn aspects.

FDT 8.2.2 AH and long-lived broadleaves (XBLL)

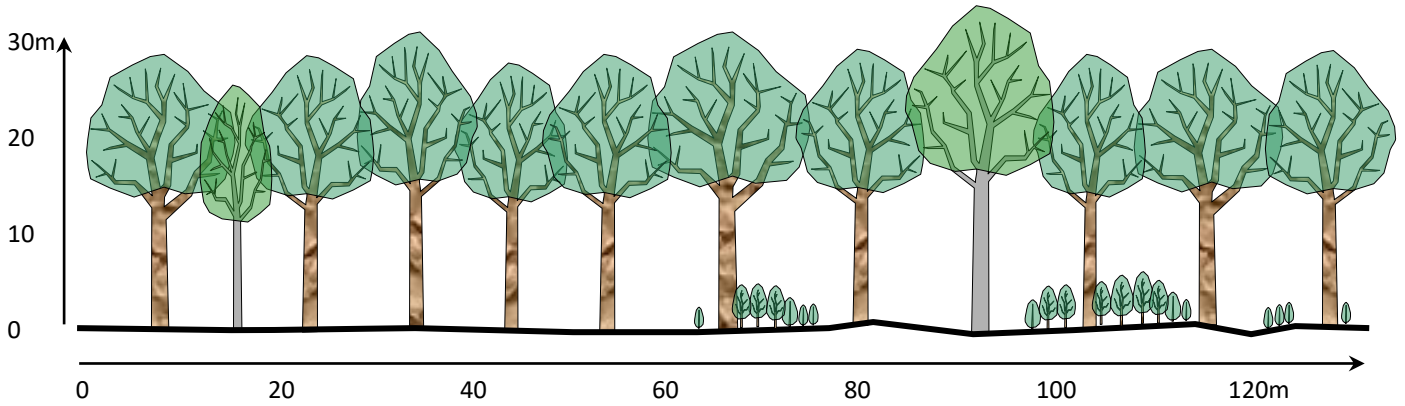
4. General management principles for the FDT

This FDT aims to produce high quality timber in a multiple-storey stand structure. Mixture compatibility between AH and XBLL will vary depending on species (CS = 1 for SY, CS = 2 for LI / WCH / HBM / BE, CS = 3 for OK). AH and light demanding XBLL should dominate the overstorey whereas shade tolerant XBLL are mostly confined to the middle and understorey. Careful selection of FC trees for timber quality is essential. Timber quality in all species involved will generally benefit from being established in robust groups rather than intimate mixture, particularly in less competitive species. Depending on tree species and spacing, clean boles in FC trees may be achieved by Q/D approach or artificial pruning. Growth response to thinning interventions in AH is strong at a young age but diminishes quickly later; crowns of AH FC trees must therefore be fully developed at an age of about 40yrs. Interventions will have to be small scale and selective in nature, leading to a complex CCF system. Depending on the effects of ash dieback the choice of FDT may have to be reviewed.

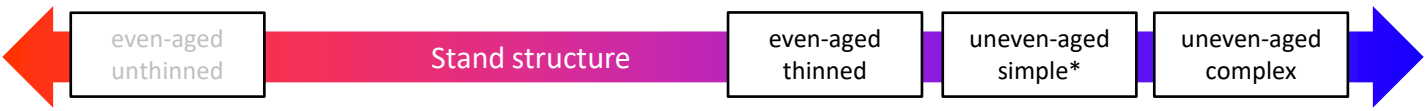
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• AH: Planting of 3000 – 5000 trees/ha or natural regeneration. • XBLL: Natural regeneration or planting in small to large groups (0.03 – 0.5ha) according to species specific guidance. Shade tolerant XBLL may also be introduced by underplanting at a later stage.
Young stand	< 3	• Protection against animals / plants as necessary. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings if regeneration is sparse.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), clearing of damage caused by felling / extraction of overstorey trees, and cleaning or pollarding of aggressive infill overtopping promising AH and XBLL. • WCH: Removal of all competing trees within 1m radius around crown.
Pole stage	8 – 12	• Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 3 competitor(s) including whips causing mechanical damage. Maintain closed canopy for ongoing self-pruning (except for WCH / WST), consider artificial pruning of WCH / WST, and of other species in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 100 FC trees/ha (AH + XBLL) and apply crown thinning to release their crowns from competitors including sub-dominant trees causing mechanical damage to FC trees (whips).
Timber stage		• Monitor competition status of FC trees, species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees; crowns of AH / WCH FC trees must remain completely free from contact with neighbouring trees. • Maintain and develop understorey, otherwise consider underplanting. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Selectively harvest FC trees as they reach target DBH. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

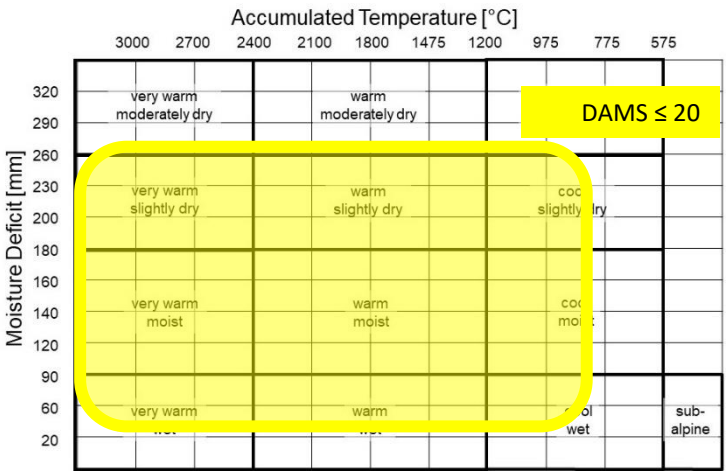
FDT 8.3.1 SY

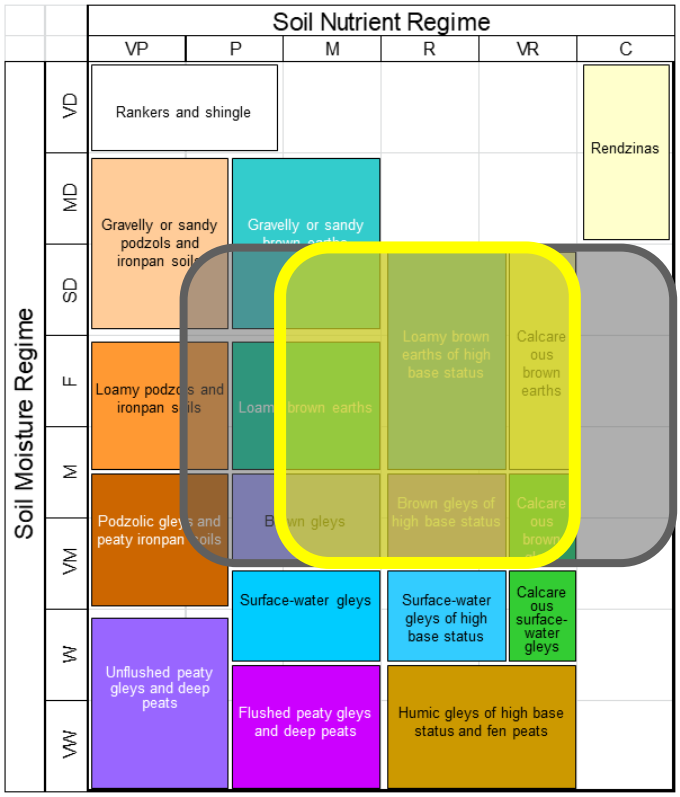


1. Structure and dynamics:
Initially single-storeyed SY stand with admixed category B species such as AH, BE, HBM, OK, BI and others.
Species distribution: SY 80 – 100% minor species: < 20%
Management under LIMA / CCF regimes, which will provide an opportunity for structural and species diversification. Most species should be propagated via natural regeneration.



2. Ecological suitability:
Represents no NVC type but provides niches for elements of W8, W9, W10 and W11. Suitable for deep, free draining loamy soils of better nutrient supply including calcareous soils.





3. Management objectives:

Economic (SY GYC > 6): SY – veneer / joinery grade / sawlogs, target DBH > 50cm in 80 – 120yrs, optional (grey squirrels)

Environmental and social: Broadleaved woodland with attractive spring aspect and autumn colours. SY also provides much of the ecological functionality of AH. The envisaged structural and species diversification is likely to increase the amenity and landscape value of this FDT further.

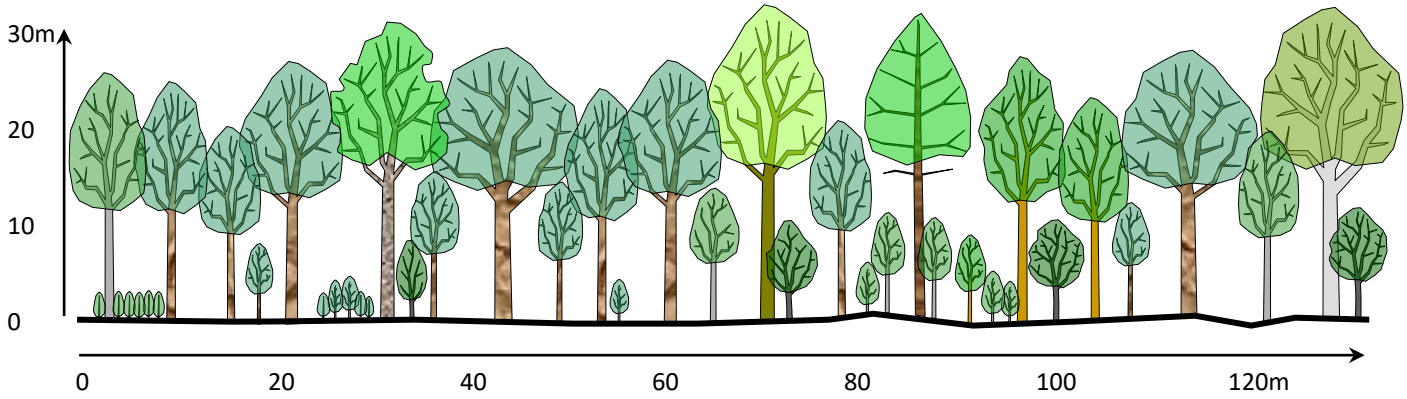
4. General management principles for the FDT

This FDT is designed for pure, even-aged stands of SY which often originate from afforestation schemes and are likely to diversify with regard to structure and species mixture over time. The presence of grey squirrels may restrict the ability to produce high quality timber. If high timber quality is a viable option, the Q/D management approach is recommended, using moderate to high initial stocking density and careful quality selection during respacing and thinning. Dominant trees of poor quality need to be eliminated by selective respacing, desirable FC trees promoted by thinning. The growth response of SY to thinning interventions is strong at young age but diminishes rapidly later; silvicultural interventions must therefore ensure the crowns of FC trees are fully developed at an age of about 40yrs. Crown thinning should be applied throughout. Thinning at later stages must aim to maintain steady growth of FC trees. LIMA / CCF methods should be used to introduce and maintain the desired horizontal and vertical stand structure.

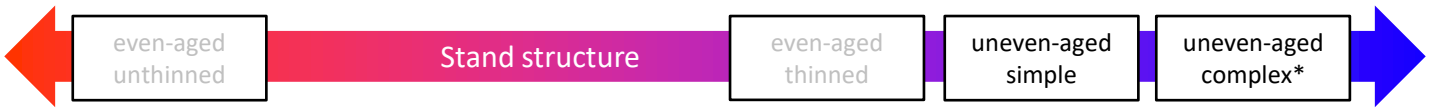
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 5000 trees/ha or natural regeneration.
Young stand	< 3	• Protection against animals / plants as necessary; in particular targeted long term control of grey squirrels. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), clearing of damage caused by felling / extraction of overstorey trees, and cleaning or pollarding of aggressive infill overtopping promising SY.
Pole stage	8 – 12	• Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 3 competitor(s). Maintain closed canopy for ongoing self-pruning, consider artificial pruning in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 100 FC trees/ha, and apply crown thinning to release their crowns from competitive neighbours. In contrast to most other XBLL a slight clumping of FC trees is acceptable.
Timber stage		• Monitor competition status of FC trees, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees. • Maintain and develop understorey where present, particularly where aggressive ground vegetation needs to be controlled. • Assess potential for natural regeneration and decide on harvesting method when FC trees approach target DBH – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

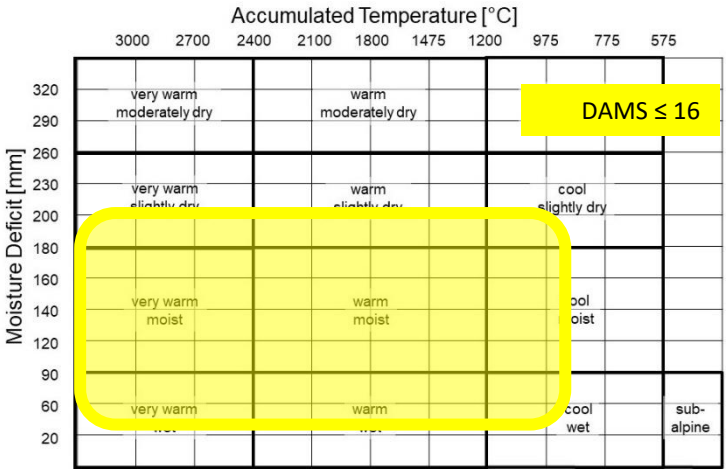
FDT 8.3.2 SY and long-lived broadleaves (XBLL)

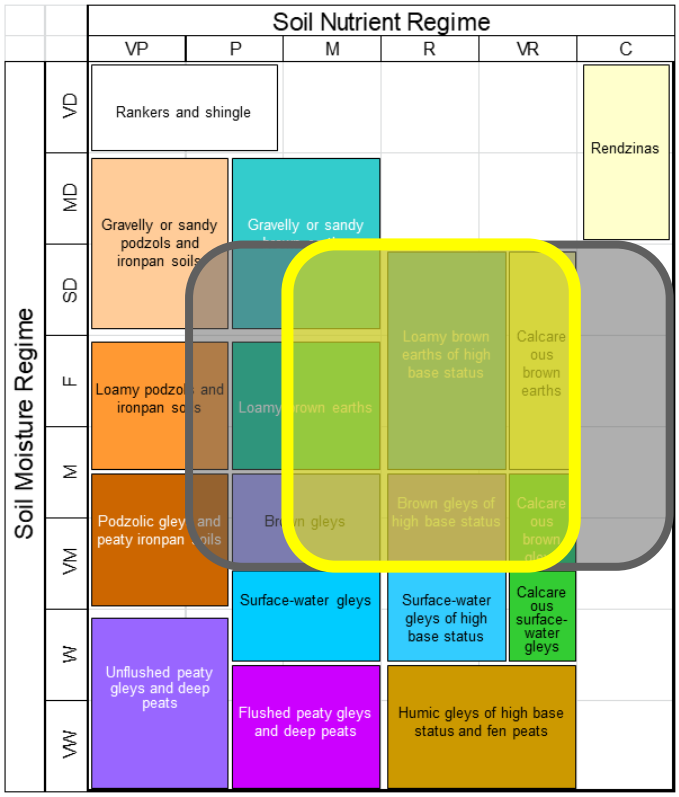


1. Structure and dynamics:
Multiple storeyed mixed stand of mainly SY, AH, EM, LI, OK, SC and WCH in small groups to patches. BE and HBM are present throughout the stand in middle and understorey, other category B minor species will be found mostly in gaps according to site conditions.
Species distribution: SY 50 – 70% XBLL 30 – 50% minor species: 20 – 40%
The complex stand structure requires small scale interventions under a CCF regime, with widespread use of natural regeneration for all species involved.



2. Ecological suitability:
Resembles NVC types W8 and W9 or early succession stages of W12 and W14. Suitable for deep, loamy, free draining soils of better nutrient supply including calcareous soils.





3. Management objectives:

Economic (SY GYC > 8):	SY – veneer / joinery grade / sawlogs, target DBH > 60cm in 80 – 100yrs, optional (grey squirrels) XBLL – veneer / joinery grade / logs / pulp / biomass
Environmental and social:	Complex forest structure and species diversity provide habitats for a range of species and lend themselves to low-impact management. Presence of veteran trees and deadwood. Attractive to visitors because of its diverse structure, spring aspect and autumn colours.

FDT 8.3.2 SY and long-lived broadleaves (XBLL)

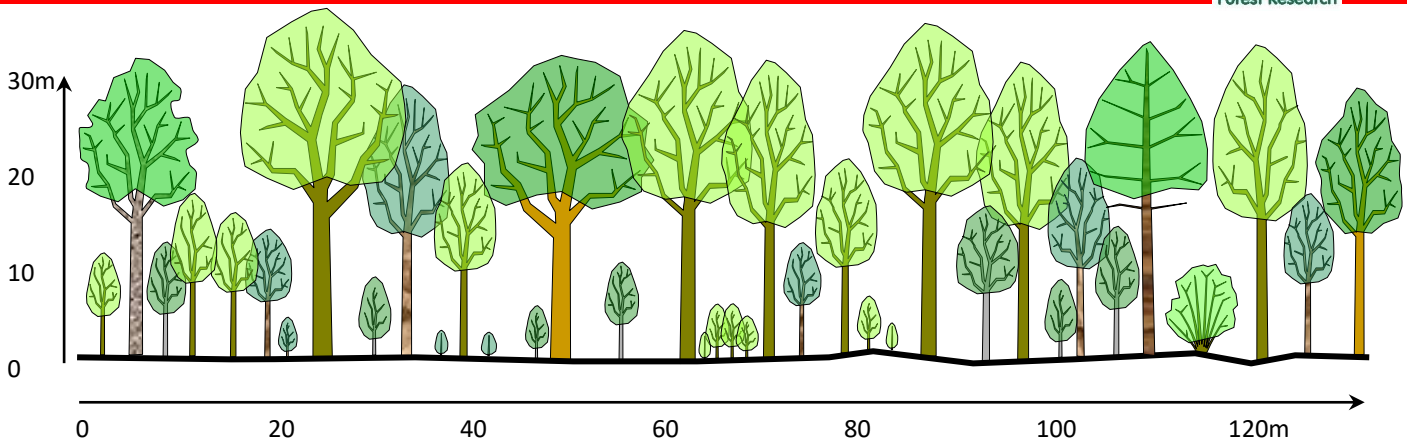
4. General management principles for the FDT

This FDT aims to produce high quality timber in a multiple-storey stand structure, however the presence of grey squirrels may restrict this. Mixture compatibility between SY and XBLL will vary depending on species (CS = 2 for AH / LI, CS = 3 for OK / WCH / BE / HBM). SY and light demanding XBLL should dominate the overstorey whereas shade tolerant XBLL are mostly confined to the middle and understorey. Careful selection of FC trees for timber quality is essential. Timber quality in all species involved will generally benefit from being established in robust groups rather than intimate mixture, particularly in less competitive species. Depending on tree species and spacing, clean boles in FC trees may be achieved by the Q/D approach or artificial pruning. Growth response to thinning interventions in SY is strong at a young age but diminishes quickly later; crowns of FC trees in SY and fast growing species such as AH must therefore be fully developed at an age of about 40yrs. Interventions will have to be small scale and selective in nature, leading to a complex CCF system.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• SY: Planting of 3000 – 5000 trees/ha or natural regeneration. • XBLL: Natural regeneration or planting in small groups to small areas (0.03 – 1ha) according to species specific guidance. Shade tolerant XBLL may also be introduced by underplanting at a later stage.
Young stand	< 3	• Protection against animals / plants as necessary, including targeted long term control of grey squirrels. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings if regeneration is sparse.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), clearing of damage caused by felling / extraction of overstorey trees, and cleaning or pollarding of aggressive infill overtopping promising SY and XBLL. • WCH: Removal of all competing trees within 1m radius around crown.
Pole stage	8 – 12	• Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 3 competitor(s). Maintain closed canopy for ongoing self-pruning (except WCH), consider artificial pruning of WCH, and other species in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 60 – 100 FC trees/ha (SY + XBLL) and apply crown thinning to release their crowns from competitors. A slight clumping of SY and BE FC trees is acceptable.
Timber stage		• Monitor competition status of FC trees, species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees; crowns of AH / WCH FC trees must remain completely free from contact with neighbouring trees. • Consider underplanting, otherwise maintain and develop understorey. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Selectively harvest FC trees as they reach target DBH. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 8.4.1. LI with long-lived broadleaves (XBLL)

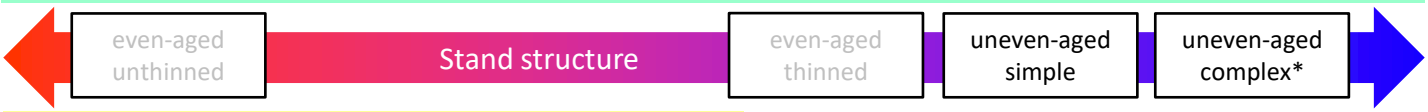


1. Structure and dynamics:

Multi-storeyed stand of dominating LI with AH, SY, OK and others in single tree to small group mixture. BE, HBM and FM are also present and occupy mainly the middle and understorey. Category C minor species mostly in gaps and along edges. Category B minor species are acceptable in the middle and understorey.

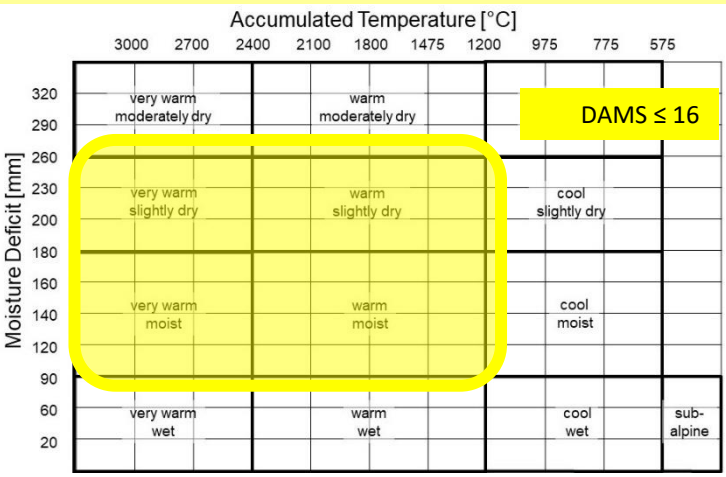
Species distribution: LI 50 – 70% XBLL 30 – 50% minor species: < 30%

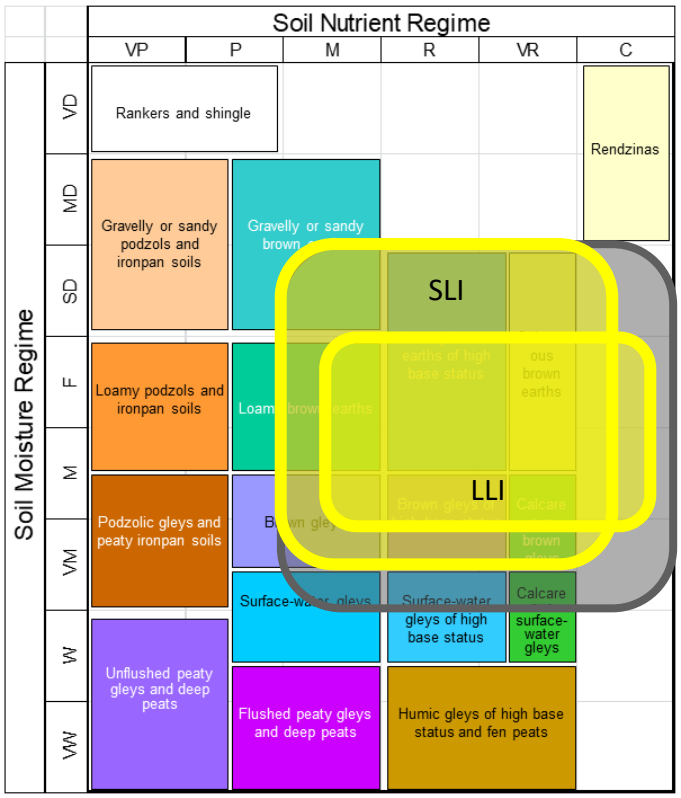
Stands may be managed under small scale clearfell-and-restock (LIMA) or CCF regimes, with management aiming to create a complex stand structure. Natural regeneration is to be used wherever possible but may have to be supplemented by planting in canopy gaps to maintain species composition.



2. Ecological suitability:

Resembles NVC types W8 and W10 but also includes elements of W12 and W14. Suitable for a wide range of soils including carbonate ones, with LLI being preferable on moister, richer and heavier, and SLI on drier, poorer and lighter soils. Neither species tolerates long-term waterlogging. A good alternative to FDT 5.3.2 with similarly high degree of diversity.





3. Management objectives:

Economic:	LI – (veneer) sawlogs, target DBH > 60cm in 70 – 140yrs
	LI – logs / pulp / charcoal
	XBLL – sawlogs / pulp / fuel
Environmental and social:	Very diverse woodland of natural appearance and high conservation value. LI suitable for coppicing, slope stabilisation and as bee pasture, XBLL to add productivity. Attractive to visitors due to its diverse structure and tree size.

FDT 8.4.1. LI with long-lived broadleaves (XBLL)

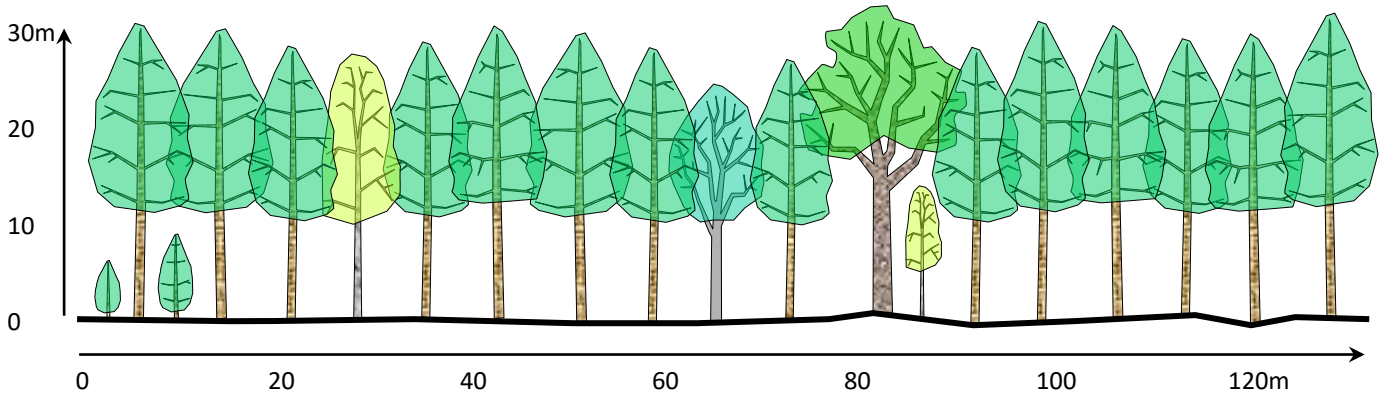
4. General management principles for the FDT

This FDT provides an alternative to 5.3.2 on sites where OK is not the desired primary species. The FDT provides rich species diversity within a multiple-storey stand structure and can produce high quality timber. LI and XBLL secondary species dominate the overstorey whereas middle and understorey are mostly composed of shade tolerant species. Mixture compatibility between LI and XBLL will vary depending on species (CS = 1 for BE and HBM, 2 for SY and AH, 3 for SC, AR and WCH); less competitive species require more support by interventions and will generally benefit from being established in groups rather than intimate mixture. Careful selection of FC trees for timber quality is essential. Depending on species and spacing, clean boles in FC trees may be achieved by Q/D approach or artificial pruning. Interventions will have to be small scale and selective in nature, leading to a self-sustaining complex CCF system. The Timeline below should therefore be interpreted as applicable to individual cohorts rather than the entire stand.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• LI: Natural regeneration in densities of > 10000 seedlings/ha or cluster planting (10 – 20 plants per cluster at 1 – 1.5m spacing), with the number of clusters corresponding to the envisaged number of LI FC trees. • XBLL: Regeneration or planting according to species specific guidance. Shade tolerant XBLL may also be introduced by underplanting later.
Young stand	< 4	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required. • Selective formative pruning of promising saplings if regeneration is sparse.
Thicket stage	6 – 10	• Negative selective respacing – removal of wolf and other undesirable trees. Cleaning or pollarding of aggressive infill if necessary. • Maintain closed canopy in groups of dense natural regeneration. • Start pruning of promising FC tree candidates where self-pruning cannot be achieved (*i.e.* in WCH or wide spacing scenarios).
Pole stage	10 – 14	• Continue negative respacing if necessary, otherwise shift focus to positive selection – carefully promote up to 300 FC (LI + XBLL) tree candidates/ha by removing 1 – 2 competitor(s). Maintain closed canopy for ongoing self-pruning and differentiation process.
Pole to small timber stage	16 – 18	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 50 – 150 FC trees/ha, and thin to release their crowns from competitive neighbours (crown thinning). • Retain sub-dominant and suppressed trees to develop a diverse stand structure, consider underplanting if understorey is absent.
Timber stage		• Monitor the development of FC trees and continue thinning to keep them free from competition. Live crown length should be > 50% of tree height. • Maintain and develop understorey to suppress epicormic growth and to control ground vegetation. Prevent understorey trees from encroaching into the crown area of FC trees. • Plan for final harvesting when FC trees approach target DBH.
Final harvesting and regeneration stage		• Selectively harvest FC trees as they reach target DBH. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 9.1.1 CAR

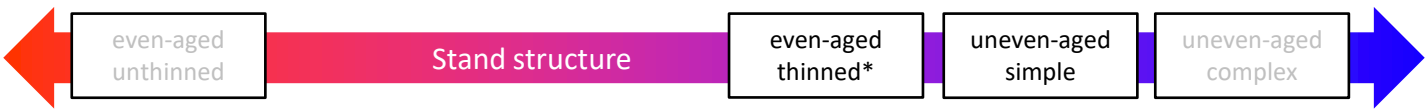


1. Structure and dynamics:

Single-storeyed CAR stand with category B minor species such as BI, AH and POK, occasionally also SY, EM, ASP, WIL, ROW, SS and NS in single tree to large group mixture.

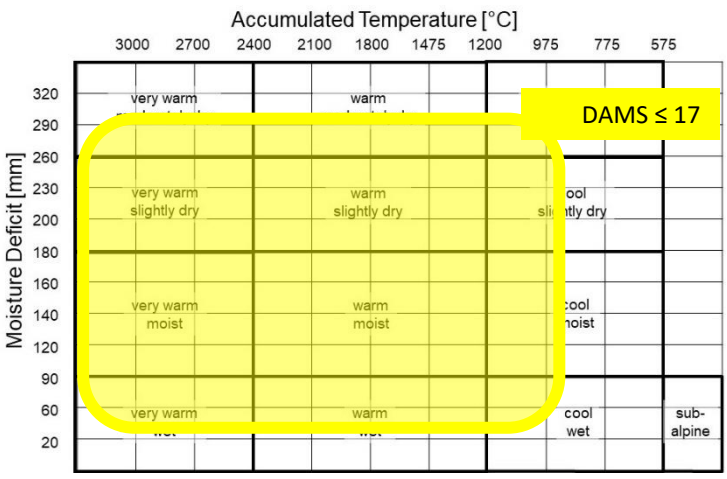
Species distribution: CAR 80 – 100% minor species: < 20%

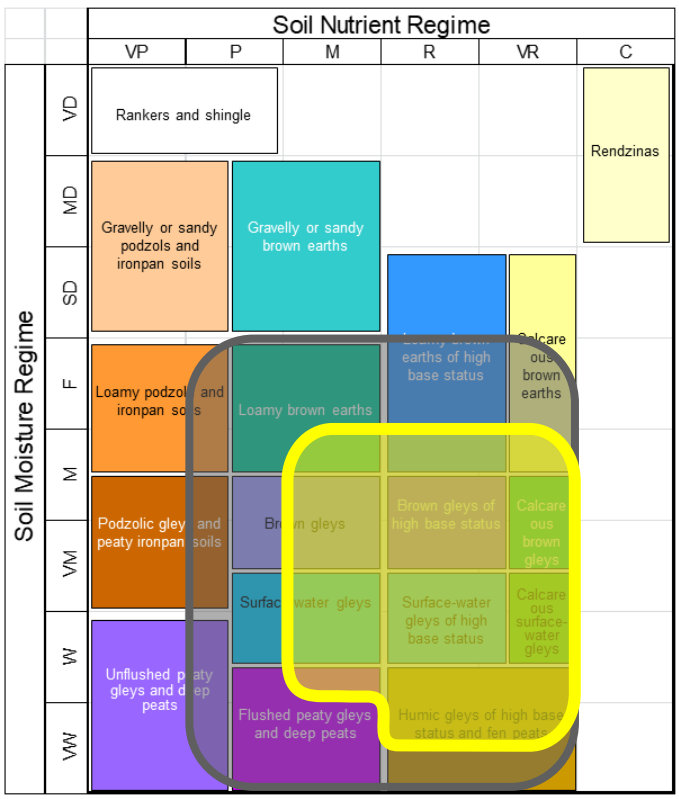
Stands are likely to be managed extensively under clearfell-and-restock regime, however opportunities for CCF / LIMA and use of natural regeneration should be used wherever possible. Coppice management is an option and may be considered on sites where access is difficult.



2. Ecological suitability:

Represents NVC types W2, W5, W6 and W7 and provides niches for elements of W1, W3 and W4 in the upland and lowland climate zones. This FDT is generally suitable for mineral and organic soil of high water supply except the poorest and strongly acidic sites. Soil improvement through Nitrogen fixation.





3. Management objectives:

Economic:	CAR – logs / pulp / biomass / charcoal
Environmental and social:	Woodland of natural appearance, providing habitats for wet woodland specialist species. Presence of veteran trees and deadwood. High value for soil improvement and water quality management in wetlands and riparian zones.

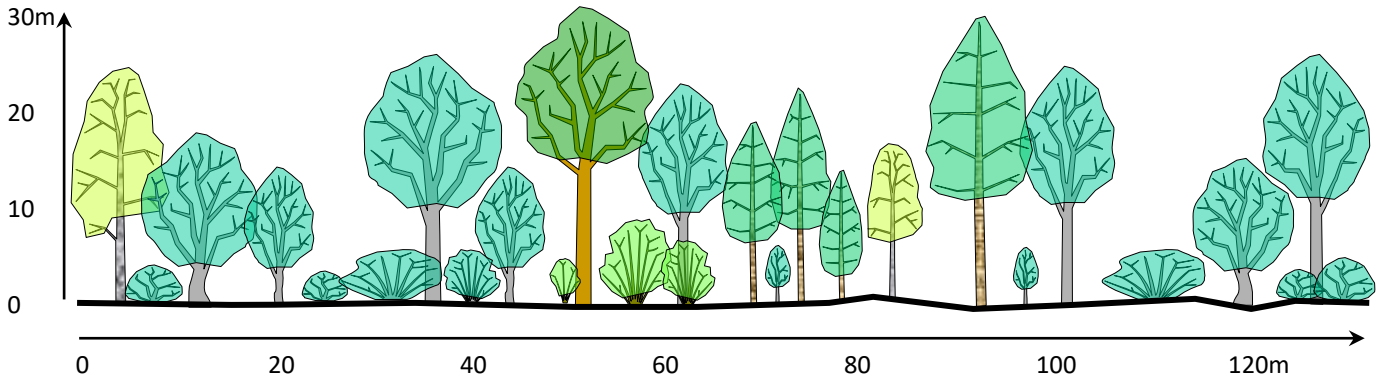
4. General management principles for the FDT

This FDT is designed for even-aged stands of CAR where management wishes to increase species and structural diversity over time. In order to achieve high timber quality the Q/D management approach is recommended, using moderate to high initial stocking density and careful quality selection during respacing and thinning. The ability of CAR to coppice may be used to achieve a high initial stocking density. Dominant trees of poor quality need to be eliminated by selective respacing, desirable FC trees promoted by thinning. The growth response of CAR to thinning interventions is strong at a young age but diminishes quickly later; silvicultural interventions must therefore ensure the crowns of FC trees are fully developed at an age of about 40yrs. Crown thinning should be applied throughout. Thinning at later stages must aim to maintain steady growth of FC trees. With increasing age CAR becomes prone to heart rot; rotation should therefore be kept below 80yrs, aiming for a target DBH of 35 – 50cm depending on site conditions. Small scale clearfell-and-restock or LIMA methods should be used to introduce and maintain the desired horizontal and vertical stand structure. On wet sites timber extraction may be difficult and consideration must be given to the use of appropriate harvesting methods and technology.

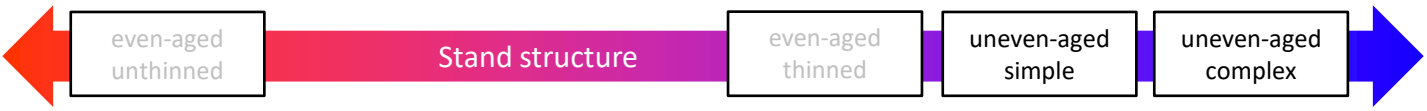
5. Timeline

stage	H_{100} [m]	intervention
Establishment		• Planting of 3000 – 5000 trees/ha or natural regeneration. Numbers may be reduced if coppice from current stools can be expected.
Young stand	< 3	• Protection against animals / plants as necessary. • Regulation of species composition and minor species as required.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), and cleaning or pollarding of aggressive infill overtopping promising CAR. • Singling of coppice shoots where applicable.
Pole stage	8 – 12	• Continue negative respacing if necessary, otherwise shift to positive selection and carefully promote up to 200 FC tree candidates/ha by removing 1 – 3 competitor(s). Maintain closed canopy for ongoing self-pruning, consider artificial pruning in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when FC tree candidates have reached the desired length of clean bole. Select 80 – 140 FC trees/ha, and apply crown thinning to release their crowns from competitive neighbours. Seed-grown trees are to be preferred over coppice.
Timber stage		• Monitor competition status of FC trees, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees; crowns of FC trees must remain completely free from contact with neighbouring trees. • Maintain and develop understorey where present. • Assess potential for natural regeneration and decide on harvesting method when FC trees approach target DBH.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed method. Due to the high light demand of CAR small scale clearfell and LIMA methods are preferable over regeneration under canopy. • Monitor ground vegetation, occurrence and growth rate of regeneration, supplement by coppicing / planting if necessary, or restock.

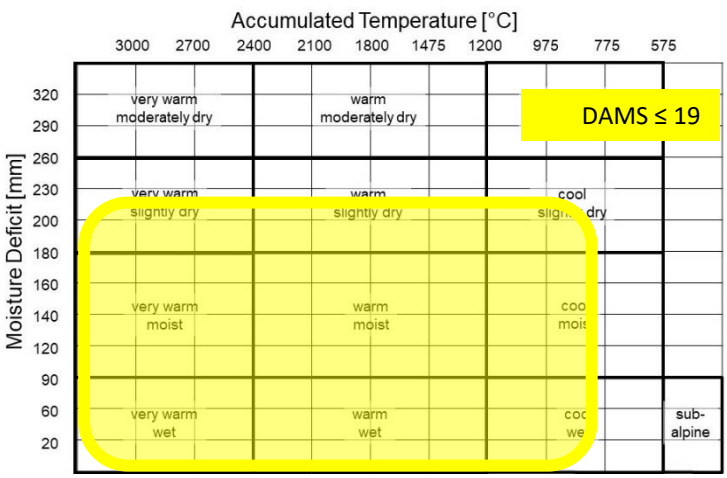
FDT 9.4.1 WIL

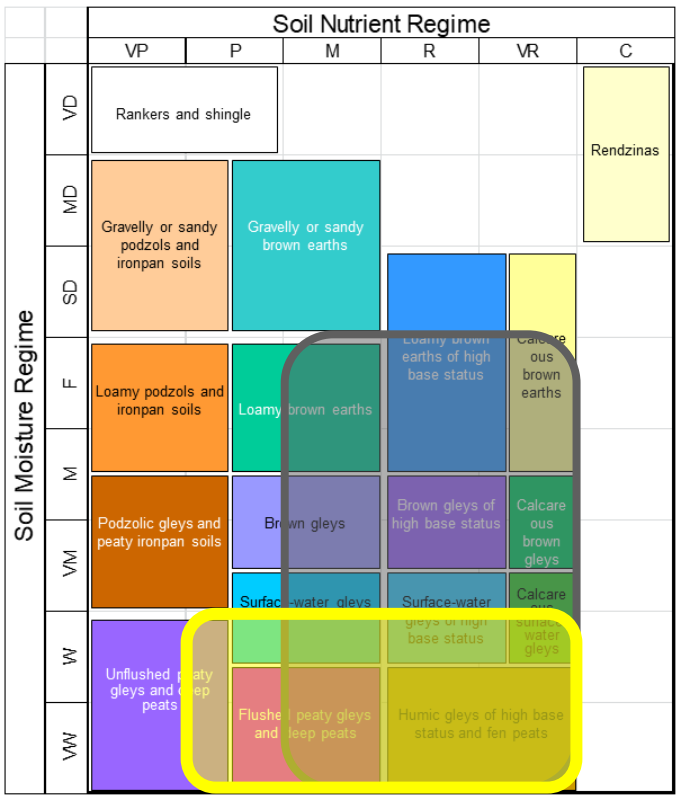


1. Structure and dynamics:
Stands of varied structure dominated by WIL and supplemented by category C minor species such as DBI, CAR, POK and others.
Species distribution: WIL 50 – 100% minor species: < 50%
This FDT often results from neglected wet pasture and local flushes. Management is usually by minimum intervention and should mainly consist of monitoring the health status and any disturbances.



2. Ecological suitability:
This FDT represents NVC type W1 and occupies wet mineral soils of good nutrient supply on the margins of standing or slow moving water and in moist hollows, mainly in the lowlands and on sandy to loamy soils.





3. Management objectives:
Economic: Limited opportunities for timber production except for niche products.
Environmental and social: High environmental value as wet habitat, for maintaining water quality and biological diversity.

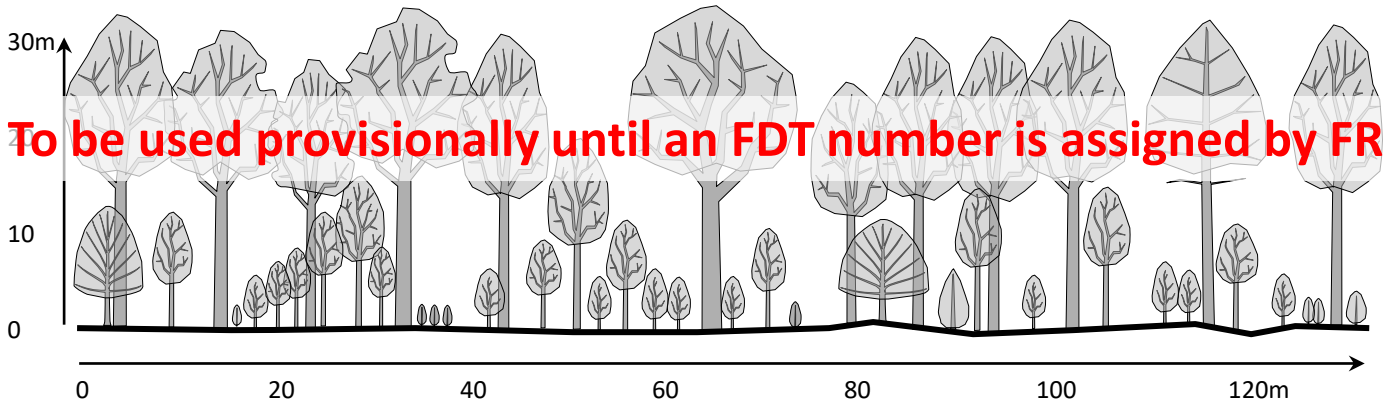
4. General management principles for the FDT

WIL is primarily managed for its value as a natural habitat and other conservation objectives, and in most cases will be categorised as a type 10 FDT. However, opportunities for other management objectives including timber production may present themselves, requiring a different management approach. The broad range of objectives that may be addressed by WIL is described below. Specific management guidance is not provided due to the very wide and different aims of management. This FDT may be particularly suitable for discrete areas within larger management units, for example, riparian zones, or patches of particularly wet soil. Regular monitoring of species composition and stand structure is an essential pre-requisite for all interventions. The use of mechanised technology must take account of the often wet ground conditions and ecological sensitivity of the site; interventions will be selective and therefore on small scale in most cases.

5. Management objectives for WIL

factor	description
Habitat & Diversity	WIL provide habitats for a wide range of animals including otters, birds, butterflies, moths and other insects. Woodlands dominated by WIL also have a distinctive ground flora associated with wet soils.
Soil improvement	Due to their fast growth rate at young age WIL and other XBSL are able to absorb available nutrients quickly, store and release them more slowly over time. This is particularly important after intensive local disturbances (*e.g.* wind damage) where these nutrients may otherwise be lost to the site. The leaf litter of WIL has a low C/N ratio and is easily decomposable, thus facilitating nutrient recycling.
Riparian zones	WIL is naturally associated with soils of high ground water table and therefore often found along rivers and streams where it contributes to bank stabilisation, prevention of erosion, balancing of water flow and regulating the water table in the soil.
Timber	Timber use opportunities from WIL include pulp, biofuel and potentially high value niche market products such as cricket bats.
Coppice	WIL coppices well, providing additional produce options such as wicker work material and facilitating coppice management and pollarding.
Infill	Infill of WIL in stands of other productive species may provide some benefits but can also have severe disadvantages. Benefits include: • Infill can provide the required high establishment density and therefore support height growth and self-pruning of suitable productive species. • WIL acts as a diversion to mammals, thus reducing browsing, peeling and fraying damage. • Soil improvement in conifer dominated stands. Disadvantages may arise from the competition between WIL infill and productive species for light, water and nutrients. As a fast growing pioneer species WIL outgrows most other species at young age and can cause growth reduction, timber quality and stability problems in the productive species. Continuous monitoring and timely intervention are therefore essential.
Nurse crop	Due to its pioneer character WIL can act as a nurse crop for more demanding or frost sensitive species. Monitoring of growth rates and competition is required.
Landscape	Wet woodlands are usually not very accessible to visitors but due to their specific character they often provide special points of interest within the forest landscape.

FDT 9.8.1 Other long-lived broadleaves (XBLL)



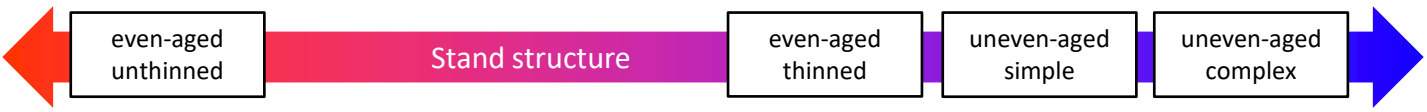
To be used provisionally until an FDT number is assigned by FR

1. Structure and dynamics:

This is a broad FDT covering any other long-lived broadleaved species, including a range of traditional species such as LI, ROK, EM and *Nothofagus spp.* but also emerging species such as hickories and maples. Stands are likely to be even-aged and single storeyed to begin with but could develop a more complex structure later. Mixture type, if applicable, may range from intimate to patches. Minor species of category B, recruiting from natural infill depending on site conditions.

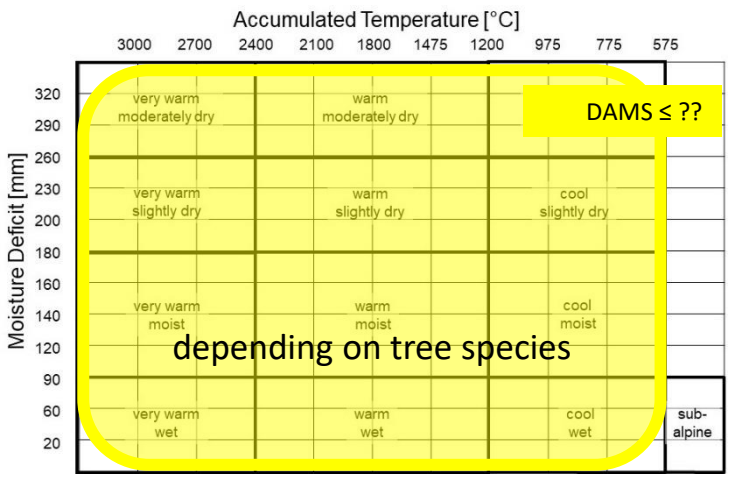
Species distribution: XBLL 30 – 100% secondary species: < 30% minor species: < 10%

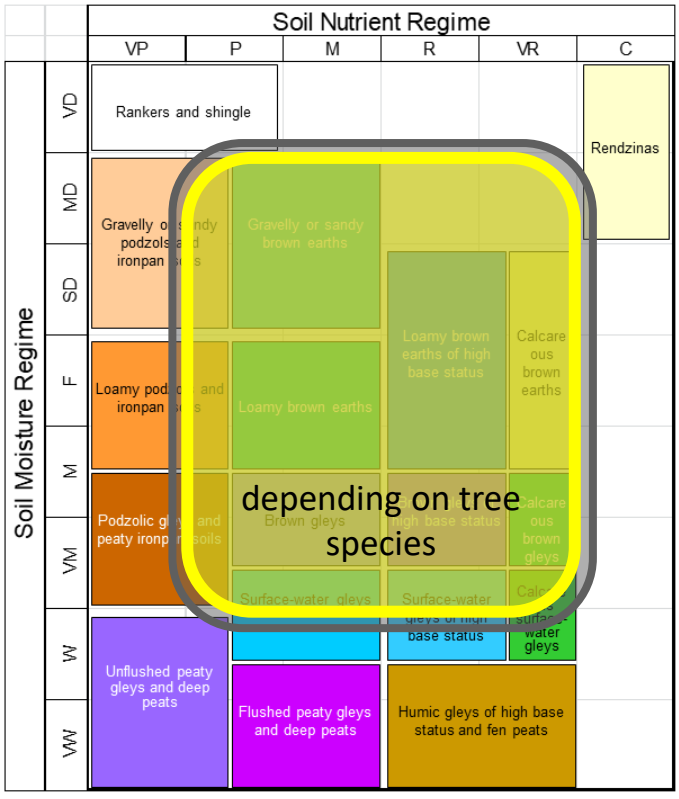
Stands may be managed by clear felling and restocking, LIMA or CCF. Natural regeneration of the major species should be used wherever possible.



2. Ecological suitability:

This broad FDT should be carefully matched to site type to ensure that the soil texture and climatic conditions are appropriate for the species, and that the FDT can deliver the management objectives for the site.





3. Management objectives:

Economic:	XBLL – optional, depending on tree species
Environmental and social:	Maintaining or improving the physical and chemical soil properties is paramount. Other environmental and social management objectives will be driven by local context.

4. General management principles for the FDT

This FDT encompasses a wide range of options, including scenarios with limited or no thinning interventions, short rotation biomass production and scenarios which may result in LIMA or even CCF management. Timber quality in broadleaved species shows much higher variation than in conifers; it is therefore essential to consider apical dominance and growth pattern (geotropic vs. phototropic) of the species when deciding on management options. Two general approaches to grow broadleaves for timber quality are given below; detailed guidance on management may be derived from other FDTs as appropriate.

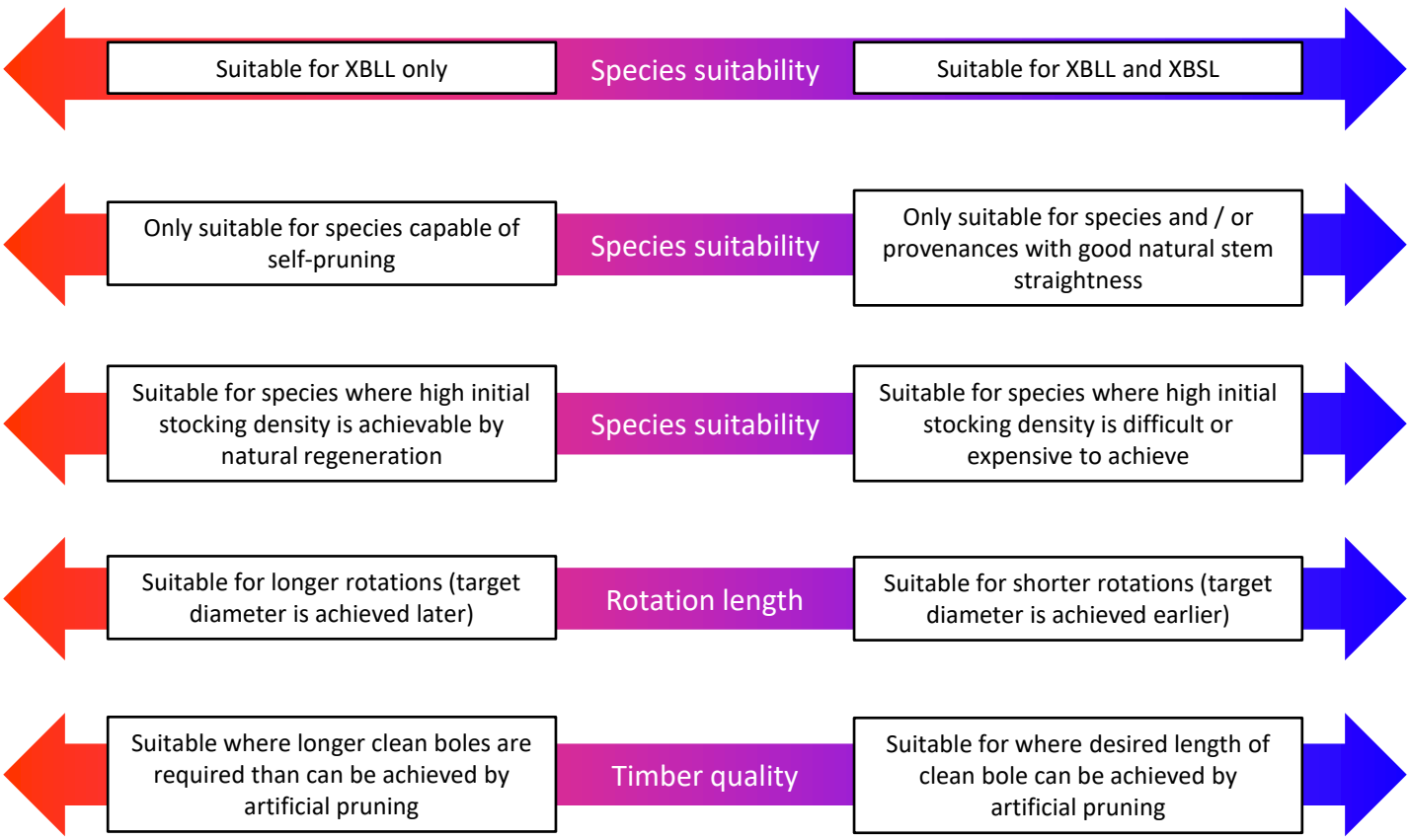
5. General management options

Q/D method

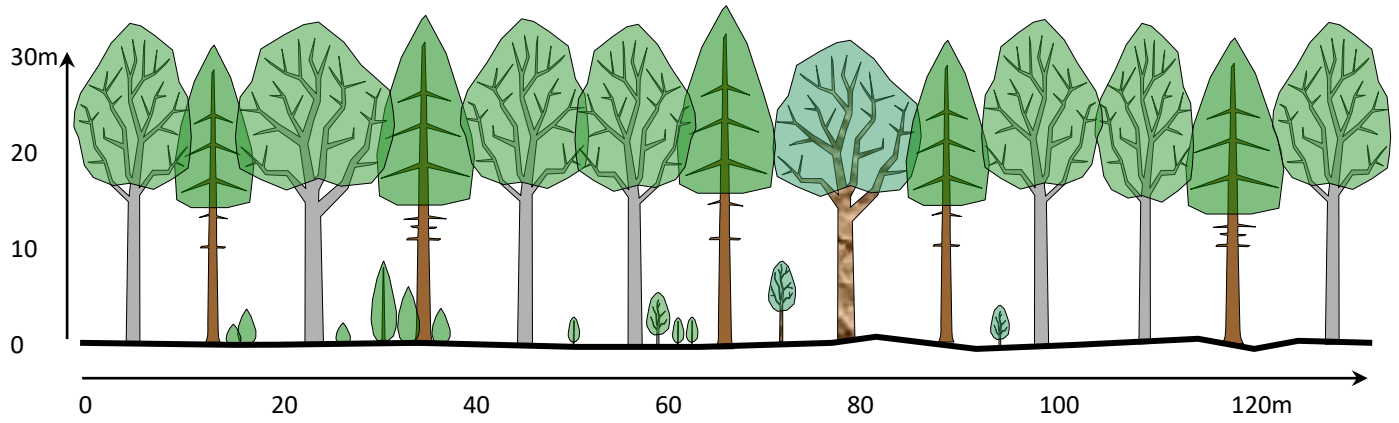
- Is a two-stage approach where timber **Q**uality is achieved in stage one and timber **D**imension in stage two.
- Stands are usually established at high density (N > 3000 trees/ha) in order to encourage stem straightness and self-pruning.
- High stand density is maintained until the desired length of clean boles has been achieved in FC trees.
- FC trees are then released from competition and managed for maximum growth towards target diameter.

Free Growth method

- Is a one-stage approach where FC trees are managed for maximum growth from the beginning and timber quality is achieved by silvicultural interventions.
- Stands may be established at low density (N < 3000 trees/ha).
- FC trees require formative pruning and / or pruning.
- FC trees are managed for maximum growth towards target diameter from early on.



FDT 9.8.2 Long-lived broadleaves (XBLL) with conifers (XC)

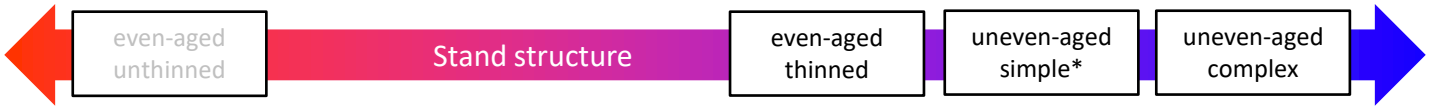


1. Structure and dynamics:

Stands with individual XC embedded in a XBLL matrix and category A minor species. The stand structure is dominated by one or several XBLL and is often even-aged and single-storeyed initially but likely to become complex later, particularly if more than two species are involved.

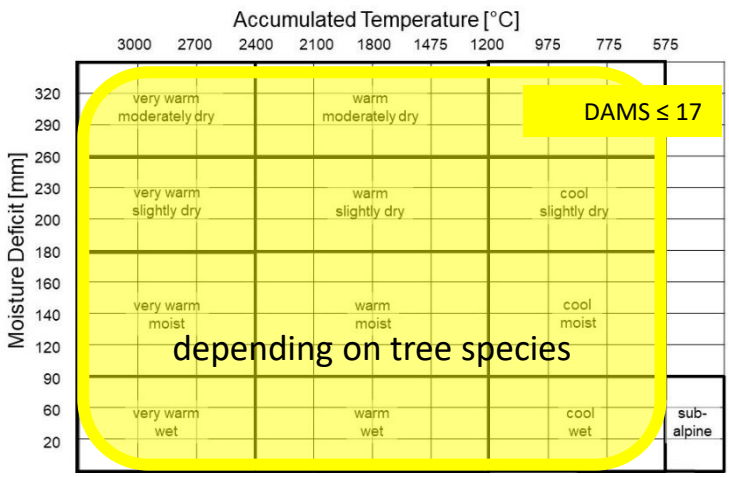
Species distribution: XBLL 50 – 80% XC 20 – 50% minor species: < 20%

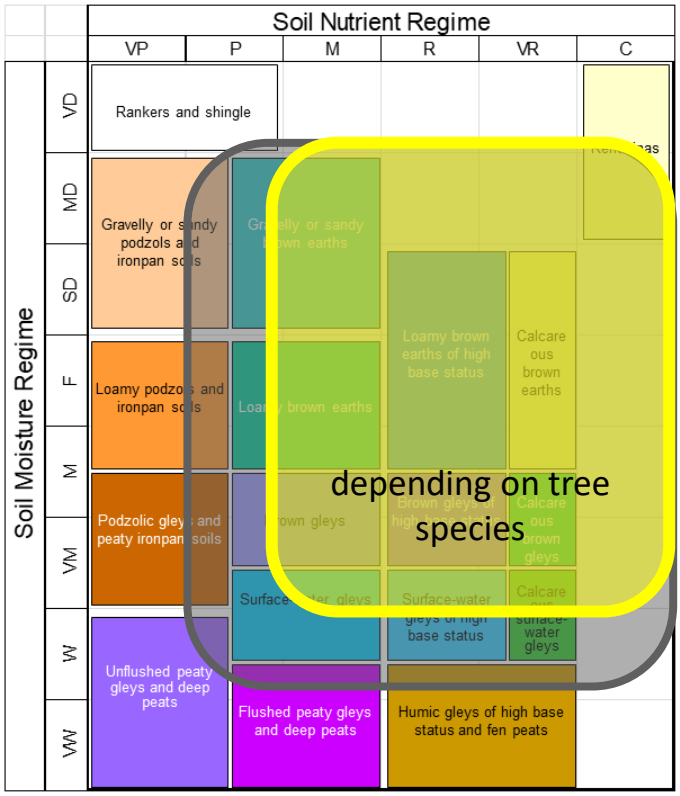
Stands are managed under LIMA / CCF regimes, with management aiming to maintain species distribution and to create a diverse stand structure, using natural regeneration wherever practical.



2. Ecological suitability:

Resembles various NVC types (W8 to 17) but includes coniferous element. Generally suitable for more fertile and freely draining soils including carbonate ones. A good option to maintain a productive XC element on PAWS sites, as long as the species proportions can be maintained.





3. Management objectives:

Economic: XBLL – veneer / logs / pulp / biomass, target DBH > 50cm in 60 – 140yrs
XC – sawlogs, target DBH > 50cm in 60 – 120yrs

Environmental and social: XBLL stand with XC elements provides diverse habitats for a range of species and will be attractive to visitors due to its mixed character and potentially diverse age structure. Structural and species diversity improve resistance and resilience with regard to risk factors.

FDT 9.8.2 Long-lived broadleaves (XBLL) with conifers (XC)

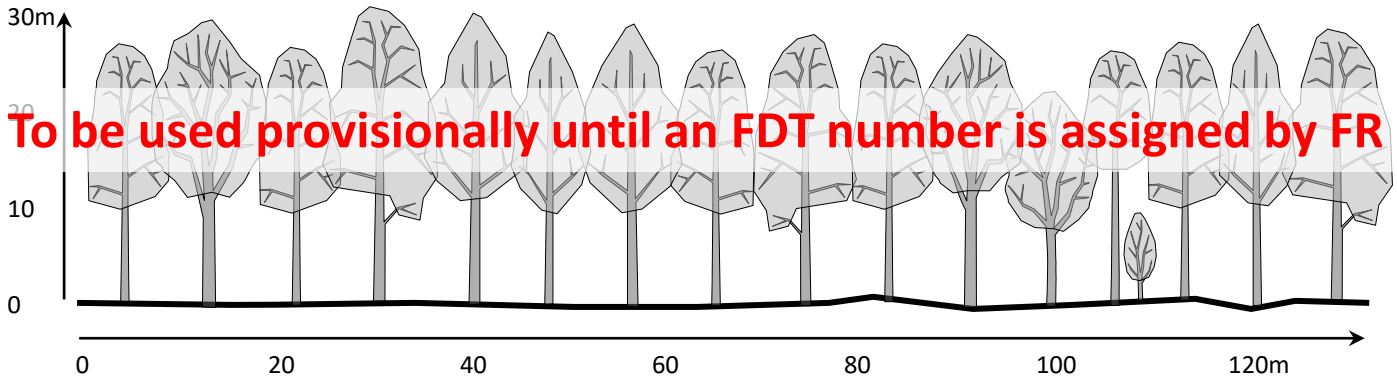
4. General management principles for the FDT

This FDT has been designed for PAWS and other scenarios where a productive XC element is to be retained within stands dominated by XB. Mixture compatibility between XBLL and XC will vary depending on tree species involved. The proportion of XC must therefore consider the species as well as the expected tree height at time of harvesting. Timber quality in XBLL will generally benefit from being established in robust groups, particularly in less competitive species. XC should always be mixed in individually. Depending on tree species and spacing, clean boles in XBLL FC trees may be achieved by the Q/D approach or artificial pruning. Developing individual tree stability is important for XC. Timing and intensity of thinning according to species specific growth rate. LIMA / CCF methods are the preferable option for final harvesting / restocking.

5. Timeline

stage	H_{100} [m]	intervention
Establishment		• XBLL: Natural regeneration or planting according to species specific guidance. Cluster planting is an option to diversify stand structure. Shade tolerant XBLL may also be introduced by underplanting at a later stage. • XC: Natural regeneration or planting in intimate mixture or small groups.
Young stand	< 3	• Protection against animals / plants as necessary. • Clearing of any damage caused by felling / extraction of overstorey trees. • Regulation of species composition and minor species as required. • Formative pruning of promising XBLL saplings if established at low density. • XC: Respacing to planting density if originating from dense regeneration.
Thicket stage	4 – 8	• Generally no interventions, except for: • Negative selective respacing (removal of undesirable trees), clearing of damage caused by felling / extraction of overstorey trees, and cleaning or pollarding of aggressive infill overtopping promising XBLL.
Pole stage	8 – 12	• Continue negative respacing in XBLL if necessary, otherwise shift to positive selection and carefully promote up to 300 FC tree candidates/ha (across all species) by removing 1 – 3 competitor(s). Maintain closed canopy within XBLL groups for ongoing self-pruning, consider artificial pruning in low density scenarios.
Pole to small timber stage	12 – 16	• Thinning interventions start when XBLL FC tree candidates have reached the desired length of clean bole. Select 80 – 150 FC trees/ha (XBLL + XC) and apply crown thinning to release their crowns from competitors. Note that slight clustering of SY and BE FC trees is acceptable.
Timber stage		• Monitor competition status of FC trees, species composition, stand density, stability and health, and thin accordingly. Apply crown thinning as long as necessary for the benefits of FC trees; crowns of AH / WCH FC trees must remain completely free from contact with neighbouring trees. • Assess potential for natural regeneration and decide on harvesting / restocking method when FC trees approach target DBH – improve conditions if necessary.
Final harvesting and regeneration stage		• Carry out harvesting operations according to agreed LIMA / CCF method. • Monitor light level, ground vegetation, occurrence and growth rate of regeneration, supplement by planting if necessary.

FDT 9.9.1 Other short-lived broadleaves (XBSL)



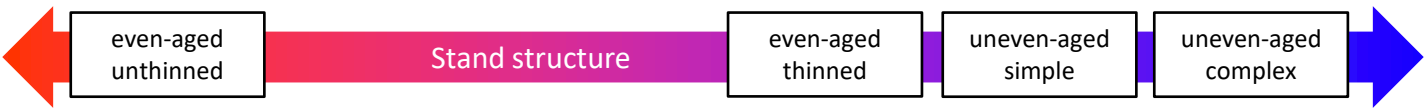
To be used provisionally until an FDT number is assigned by FR

1. Structure and dynamics:

This is a broad FDT covering any other short-lived broadleaved species such as ASP and PO, emerging species such as eucalypts, and short rotation options. Stands are likely to be even-aged and single storeyed to begin with but could develop a more complex structure later. Mixture type, if applicable, may range from intimate to patches. Minor species of category A, recruiting from natural infill depending on site conditions.

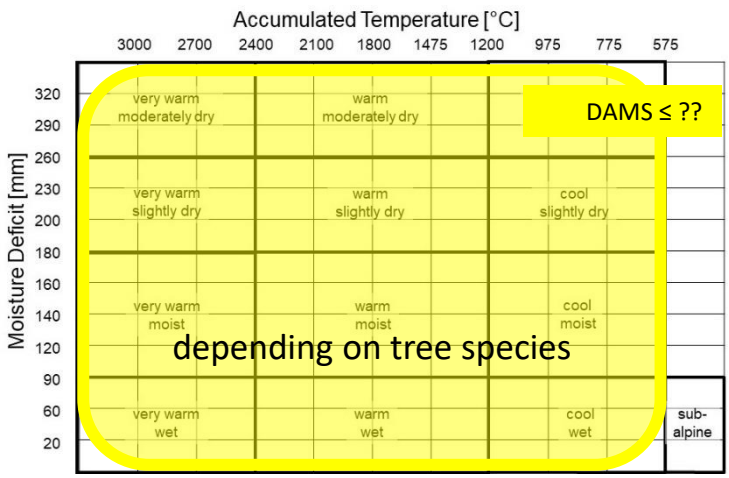
Species distribution: XBSL 30 – 100% secondary species: < 30% minor species: < 10%

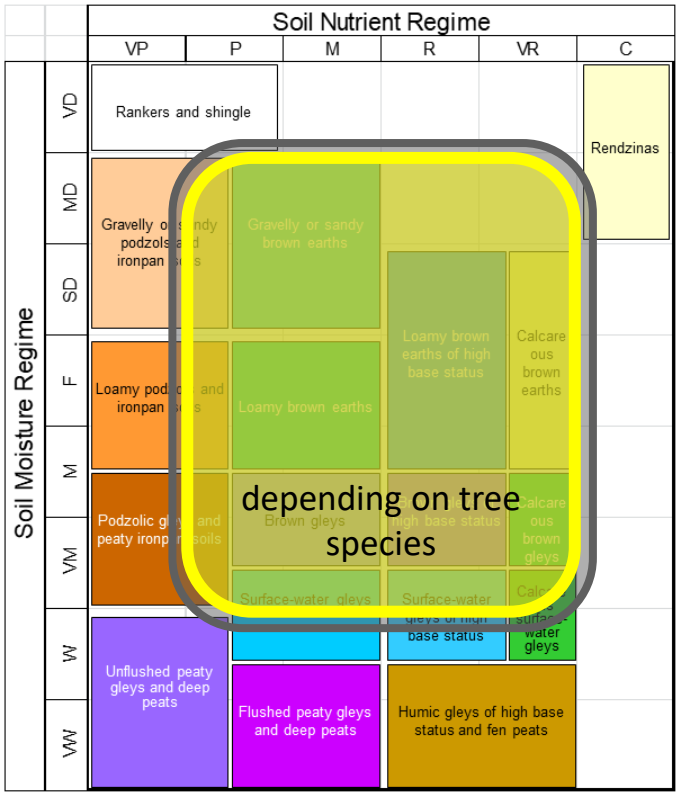
Stands may be managed by clear felling and restocking, LIMA or CCF. Natural regeneration of the major species should be used wherever possible.



2. Ecological suitability:

This broad FDT should be carefully matched to site type to ensure that the soil texture and climatic conditions are appropriate for the species, and that the FDT can deliver the management objectives for the site.





3. Management objectives:

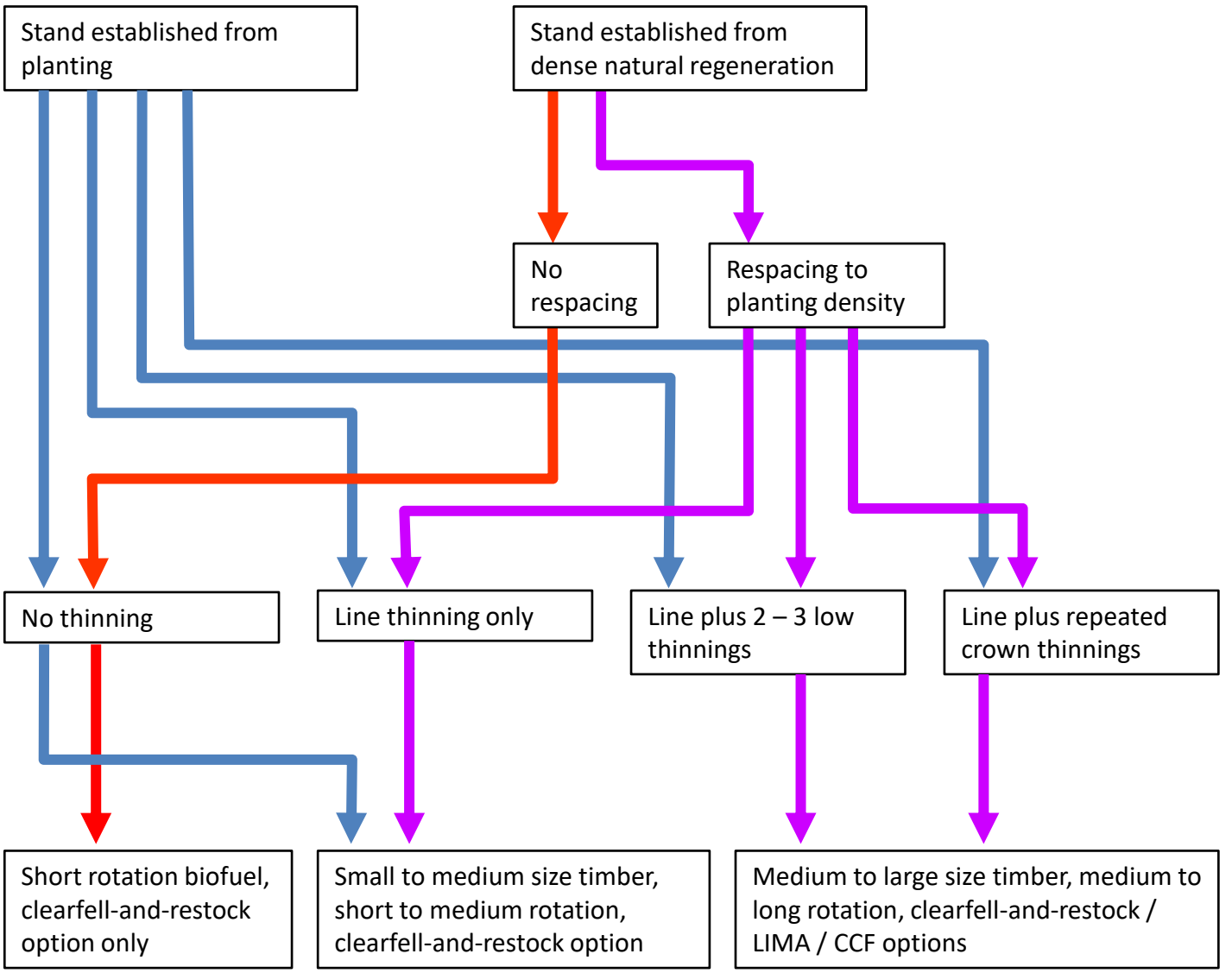
Economic: XCLD – optional, depending on tree species

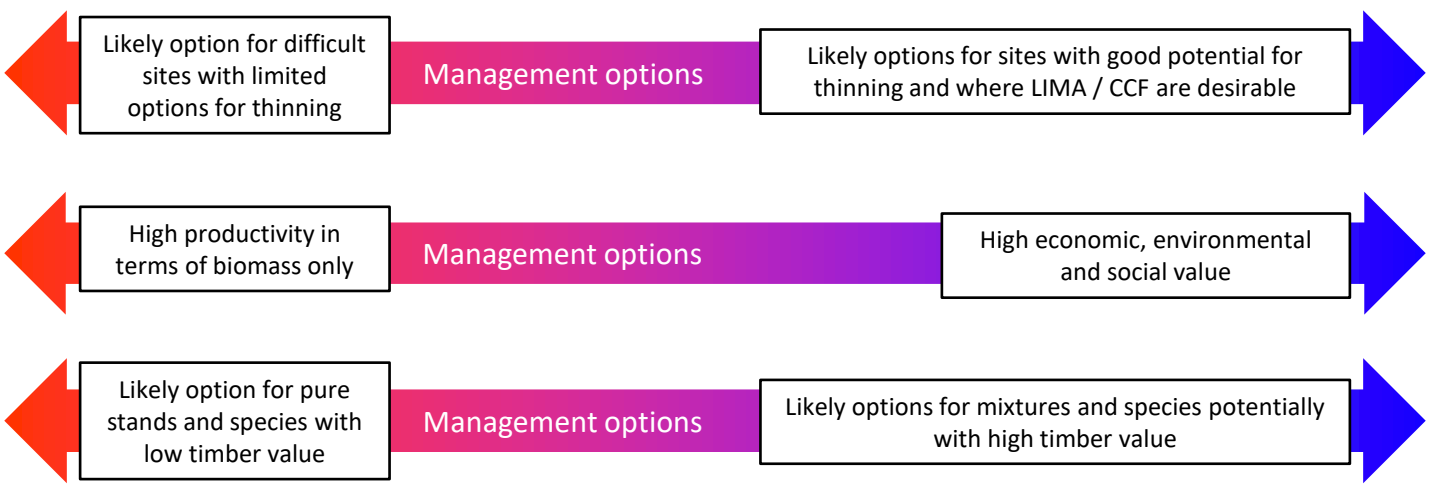
Environmental and social: Maintaining or improving the physical and chemical soil properties is paramount. Other environmental and social management objectives will be driven by local context.

4. General management principles for the FDT

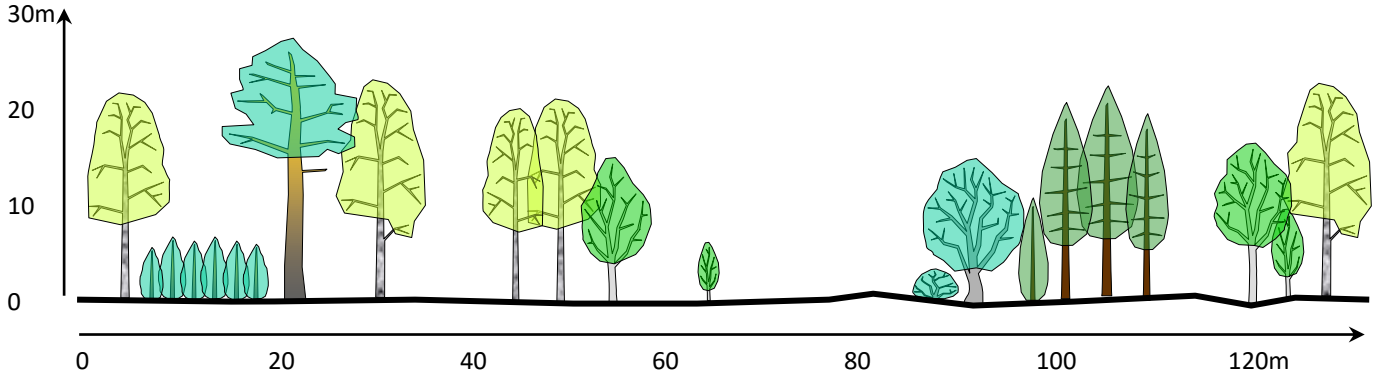
This FDT encompasses a wide range of options, including scenarios with limited or no thinning interventions, short rotation biomass production and scenarios which may result in LIMA or CCF management. A general overview is given below; detailed guidance on management may be derived from other FDTs as appropriate.

5. Overview



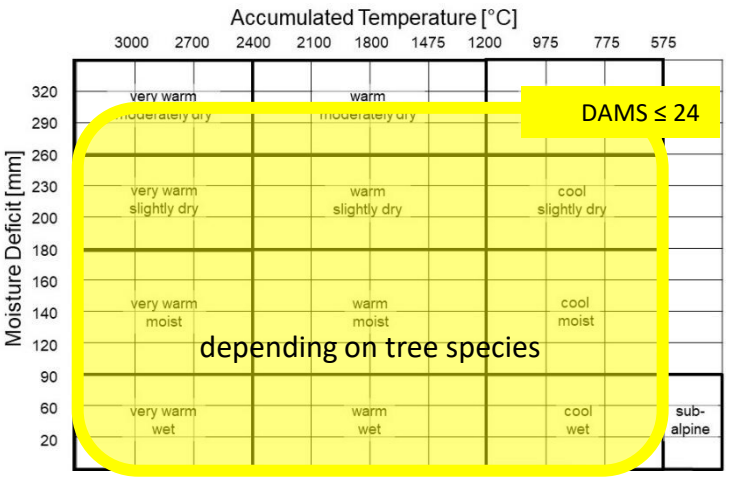


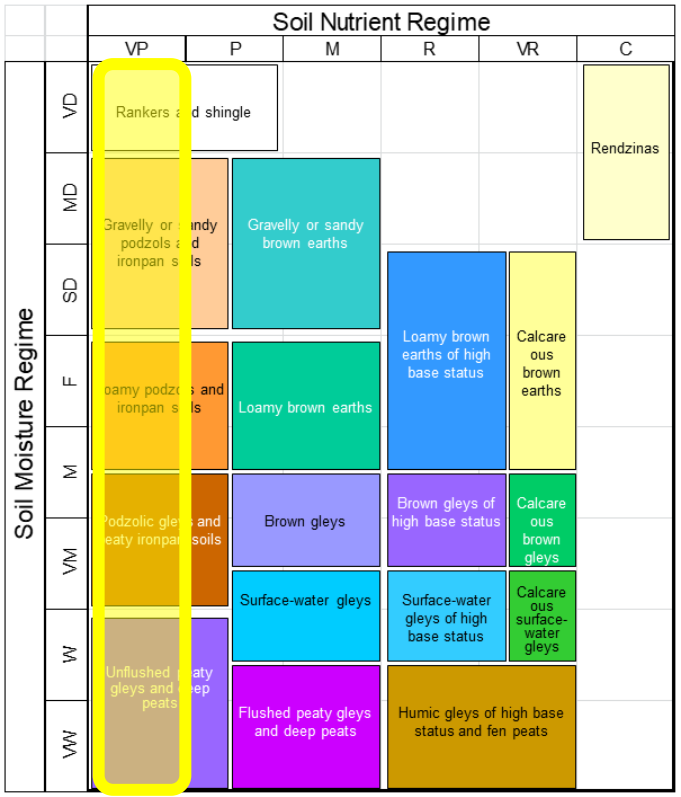
FDT 10.1.1 Peat edge woodland (PEW)



1. Structure and dynamics:
Designed for scenarios after clearfelling on sites which are neither suitable for productive XC nor peat restoration. Open forest with 20 – 80% tree cover, arranged as mosaic of single-storeyed native species such as BI, WIL, ASP, ROW, SP and open ground. A proportion of non-native XC may be permissible as minor species if originating from natural regeneration where the FDT borders on adjacent productive XC stands.
Species distribution: XBSL / SP 80 – 100% minor species: < 20%
The FDT will be managed by minimum intervention to retain multiple management options in the future. Stand structure is likely to evolve over time depending on species composition and local site conditions; interventions should only be carried out to maintain the proportion of open ground and the species composition.

2. Ecological suitability:
Contains important elements of NVC types W4 and W18. This FDT belongs on very poor peaty soils (including peaty rankers and peaty podzols) in areas which are deemed unsuitable for restocking with productive XC, often adjacent to open peatland.





3. Management objectives:
The primary purpose of this FDT is to retain woodland cover on areas which are not deemed suitable for peatland restoration but where conventional restocking to productive stands might incur net carbon loss. The FDT can also be used to manage a buffer area between productive XC stands and open peatlands.
Economic: logs / pulp / biomass (optional / unlikely)
Environmental and social: Due to the native species components and the proportion of open ground these stands combine biodiversity and visual benefits of woodland and peatland habitats.

4. General management principles for the FDT

This FDT is primarily managed for tree cover as a measure of carbon fixation and environmental purposes on sites where restoration of open peatland is deemed unfeasible. It is also appropriate as a buffer zone between productive XC stands (*e.g.* FDTs 1.1.1, 2.3.1 or 2.3.2) and open peatland. The objective is to create an open woodland with 20 – 80% canopy cover resembling NVC types W4 and / or W18 which requires little intervention. Non-native XC are permissible as a minor species element if adjoining existing XC stands. Stand establishment should be carried out without ground cultivation, preferably by natural regeneration or direct seeding. Primary species may be planted at standard density if necessary; planting design should account for open space. The stand will require regular monitoring for browsing damage, species composition, occurrence of natural regeneration and invasive species. Required interventions should be kept to a minimum and should normally only be necessary to maintain some open ground and control the proportion of non-native XC, or to remove invasive species. Interventions for timber production are not explicitly ruled out but are highly unlikely due to the nature of the FDT. The use of mechanised operations in any intervention must take account of the ground conditions and ecological sensitivity of the site. The FDT should be periodically reviewed in the light of the results of monitoring, required interventions, and amendments to peatland restoration policy.

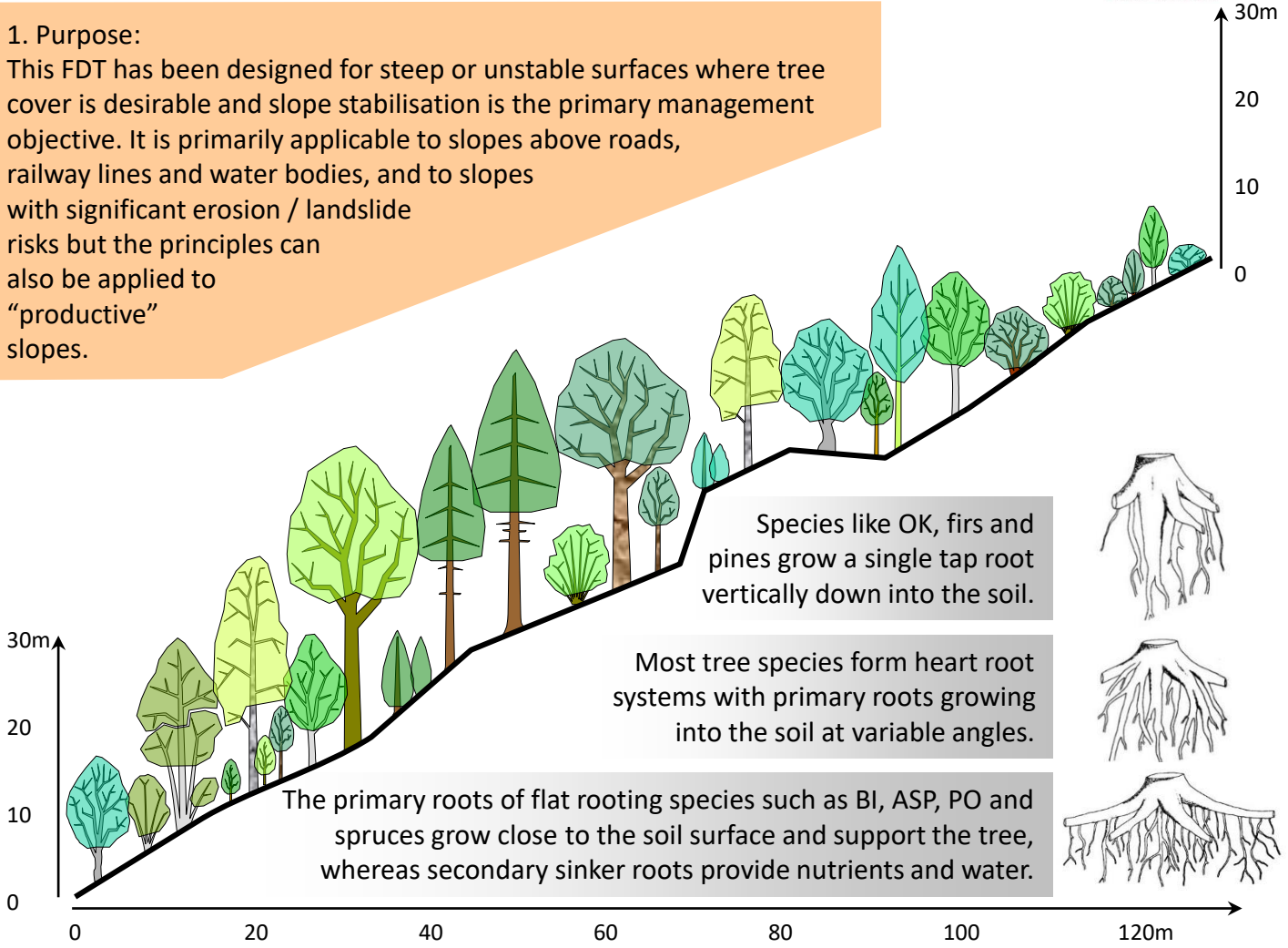
5. Overview

stage / action	comment
Establishment	• XBSL / SP: Planting of 500 – 2000 trees/ha or natural regeneration. • XC: natural regeneration on < 20% of area. • Planting limited to suitable area, retain proportion of open ground.
Monitoring	• Monitor browsing damage, stand development, species composition, proportion of non-native XC, open ground proportion, occurrence of invasive species.
Intervention	• Control of species composition. This can be achieved by removing undesirable tree species (*e.g.* non-native XC) or measures to alter site conditions (*e.g.* blocking drains to increase the water table level). • Maintaining open ground component. • Protective measures against undue browsing damage.
Review	• Be aware of possible changes in peatland management practice and policy. • Review FDT if necessary.

Examples of peat edge woodland
Photos by Russell Anderson,
Forestry and Land Scotland

FDT 10.1.2 Slope stabilisation woodland (SSW)

1. Purpose:
This FDT has been designed for steep or unstable surfaces where tree cover is desirable and slope stabilisation is the primary management objective. It is primarily applicable to slopes above roads, railway lines and water bodies, and to slopes with significant erosion / landslide risks but the principles can also be applied to "productive" slopes.



2. Structure and dynamics:
Mixed species stand with complex structure in single tree to small group mixture. Although this FDT may have to be established by planting or direct seeding initially, it should be self-propagating by natural regeneration later. Species choice should focus on site adapted species which establish quickly but grow more slowly later. Deep rooting species are preferable, with further management promoting short trees with good taper and stability. Suckering species such as ASP may be considered for their fast establishment and soil retention ability. Management may be via coppicing, or CCF / LIMA approaches, avoiding ground disturbance and exposure of bare soil. May incorporate debris catchment zones on lower slopes.

2. Ecological and Climatic suitability:
Appropriate in any climatic zone wherever soil conditions, slope angle and geology result in instability. Slope instability may increase during heavy rainfall events, particularly following periods of drought. Species selection should prioritise native site-adapted species (*i.e.* locally suitable NVC type) according to soil conditions. Fast-establishing pioneer species and shrubs should be included in the mixture; stand diversity and stability are more important than growth rate! Consider the effect of slope aspect on microclimate, and therefore species suitability. Steep slopes are usually freely draining and soil may have limited water-holding capacity if shallow and / or stony.

3. Management objectives:

Economic:	erosion control, prevention of landslides as indirect benefits logs / pulp / biomass (optional / unlikely)
Environmental and social:	Due to the native species components and the diverse structure these stands combine biodiversity and visual benefits of woodland, often in exposed and highly visible locations.

4. General management principles for the FDT

This FDT is primarily managed for tree cover to provide slope stabilisation and other environmental purposes. The objective is to create a well-structured stand of multiple species requiring little, and only low-intensity, intervention. Stand establishment must be carried out without ground cultivation, preferably by natural regeneration or direct seeding. Mixtures should be intimate or in small groups but must still consider species compatibility. Establishment density may be lower than in standard planting scenarios. Required interventions should be kept to a minimum and should be carried out using appropriate technology and work methods. Interventions for timber production are possible but are highly unlikely due to the site conditions – felled trees may be used as debris catchment features instead.

5. Overview

stage / action	comment
Establishment	• No mechanised cultivation methods, hand screefing is acceptable. • Planting of 500 – 2000 trees/ha, natural regeneration, or direct seeding.
Design	• Long slopes may be divided into various zones of different functionality, *e.g.* upper zone of dwarf shrubs and fast establishing species to retain soil in place, middle zone of mixed tree sizes to catch water and slow down mobile debris, lower zone with debris catchment and amenity / landscape function.
Monitoring	• Monitoring stand development is essential to identify problems early enough.
Respacing	• Control of species composition and density, particularly if establishment is by natural regeneration. Large pockets of dense XC regeneration should be broken up in the interest of individual tree stability. • Consider using coppicing methods for suitable tree species.
Thinning	• Thinning interventions should aim to maintain species composition and to diversify the stand structure. Tree selection should favour short and stable trees. • Operations are likely to be motor-manual, timber extraction optional. Leave higher than usual stumps and use contour felling to turn produce into debris barriers.
Final harvesting and regeneration	• Monitor light level, ground vegetation, occurrence and vigour of natural regeneration. Supplement regeneration by planting if necessary. • Apply a suitable CCF method (selection system or shelterwood) for final harvesting. • Select appropriate technology and work method, avoid undue ground disturbance.

6. Soil erosion risk

Soil erosion depends mainly on slope gradient and soil texture as shown in the matrix below.

	slope gradient						
	flat	gentle	moderate	moderately steep	steep	key	erosion risk
	< 2°	2 - 5°	5 - 10°	10 - 18°	18 - 30°	1	low
soil texture	< 3.5%	3.5 - 9%	9 - 18%	18 - 32.5%	32.5 - 58%		
peaty	5	5	5	5	5	2	low to medium
sandy / gravelly	2	3	4	4	5	3	medium
loamy	2	2	3	4	4	4	medium to high
clayey	1	2	2	3	4	5	high