



# Management in 4C: description of method and control

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## 1. Adaptive management (flag\_mg=2)

This management type was developed for special analyses in Brandenburg (Germany).

### 1.1 Thinning

Thinning is controlled by height-growth intervals (younger stands) and by time intervals (older stands). The measures are selected according to instructions for Brandenburg.

#### 1.1.1 Tending of plantations (dominant height at 3 m)

- Withdrawal of 30% for spruce and Douglas fir, at half withdrawal of the strongest trees and at the other half evenly distributed over all trees
- Withdrawal of 30% for beech, oak and Scots pine, at half withdrawal of the strongest trees and at the other half evenly distributed over all trees

#### 1.1.2 Brushing (dominant height at 9 m)

optional as:



- a) moderate Thinning from below
  - Withdrawal the trees of the retired stand with WEIBULL-function and parameter  $k_B = 1,8$  (WENK/ GEROLD) until 1/10 of basal area is reached/ withdrawn
- b) heavy Thinning from below
  - Withdrawal the trees of the retired stand with WEIBULL-function and parameter  $k_B = 1,6(?)$  (WENK/ GEROLD) until 1/10 of basal area is reached/ withdrawn
- c) (low) Thinning from above
  - Withdrawal the trees of the retired stand with WEIBULL-function and parameter  $k_B = 1,2$  (WENK/ GEROLD) until 1/10 of basal area is reached/ withdrawn
- d) Selection-Thinning
  - Withdrawal normally distributed from the strongest third of all trees, the double number of the selection trees (alternative: withdrawal with adjusted WEIBULL-function over the strongest third of all trees)

### 1.1.3 Tending of younger stands (dominant height at 12 m and 15 m)

optional as:

- a) moderat Thinning from below
  - same procedure as 2.a (brushing)
- b) heavy Thinning from below
  - same procedure as 2.b (brushing)
- c) (low) Thinning from above
  - same procedure as 2.c (brushing)
- d) Selection-Thinning
  - Withdrawal normally distributed from the strongest third of all trees, the one and a half number of the selection trees (alternative: withdrawal with adjusted WEIBULL-function over the strongest third of all trees)

### 1.1.4 Tending of stands (dominant height > 15 m)

Controlled with time intervals from x years

optional as:

- a) moderate Thinning from below
  - same procedure as 2.a (brushing)
- b) (low) Thinning from above
  - same procedure as 2.c (brushing)
- c) Selection-Thinning



- Withdrawal normally distributed of the second third of the strongest of all trees, same as number of selection trees (alternative withdrawal with WEIBULL-function over the second third of strongest of all trees)

### 1.1.5 Set a system of skidroads

optionally at one of the thinning phases 1. To 4.

- by distances of skidroads with 25 till 30 m and a width of 4 m: 15% of the number of all trees were withdrawn in equally distribution (proportionately to the withdrawal of trees at 15% of the whole area)

## 1.2 Regeneration

Age-definitions:

Age U = Rotation period	for Scots pine	=	140 years
(Brandenburg)	for oak	=	160 years (till 240 years)
	for beech	=	150 years
	for spruce	=	110 years
	for birch, elder, poplar	=	80 years

Age X = Age of beginning regeneration (planting, natural regeneration)

(Brandenburg)	for Scots pine	=	110 years
	for oak	=	130 years (bis 240 years)
	for beech	=	110 years
	for spruce	=	80 years
	for birch, elder, poplar	=	60 years

Regeneration of trees in three version, optional as:

#### a) Clear Cutting

- Ex age U minus 15 years no thinning until reaching age U
- At age U clear cutting and planting of young trees (starting of initialization)

#### b) Shelterwood-Management

- Starting of regeneration at age X through
  - Withdrawal of 30% of the basal area of the stand from second and least third of the strongest of all trees (with WEIBULL-function or equally distributed), substitute for the regular thinning at this age
  - Initialization of regeneration (Natural regeneration) or man-made (planting of younger trees under older trees)
- To continue the regeneration at age X+15 through



- Withdrawal of 40% of the basal area of the stand from second and least third of the strongest of all trees (with WEIBULL-function or equally distributed), substitute for the regular thinning at this age
- Taking over of regeneration at age U by
  - Cutting the older trees
  - Taking over (describe new) of the Understore = the regeneration as the main-stand

### 1.3 Remarks

- Nearly all values of thinning parameters can be modified by a management control file which has to specify for a stand
- Modification are possible for:  
thinning intensity, thinning 'height' and thinning period, rotation time

### 1.4 Management control

Description of input data for adaptive management (flag\_mg = 2)

! 1.Row : ho1,ho2,ho3,ho4 (cm): target values for dominant height

! 2.Row: thinning regimes thin\_flag1, thr1,...thr6, thr7, mgreg

! thin\_flag1 = 0 : tending / = 1: no tending

! thinning types für thr1...thr4:

! 1 – thinning from below low thinning ( moderate)

! 2 - thinning from below (heavy)

! 3 – thinning from

! 4 - selective thinning

! thr5: 0 – no skid roads, 1 – with skid roads

! thr6: hoi – height value for skid roads

! thr7: harvesting regime: 0 - nothing 1 - shelterwood 2 – clear cut

!

mgreg	regeneration	pine %	oak %
0	nothing		
1	natural; controled by species.par		
2			
3	Multi-cohort appr.		
4	planting	20	80
5	planting	30	70
6		50	50
7	planting	70	30
8	planting	90	10
9	Mixed stand, definded		



	in the model (amod_plant)		
10	pine		
11	beech		
12	oak		
13	spruce		
14	birch		
20	planting file		

- ! 3.Row : +/- limits for hoi (cm)
- ! 4.Row : thinning period if hdom>ho4
- ! 5.Row : rel. reduction in the case of skidding roads
- ! Row 6-9: order of species: beech, spruce, pine, oak, birch
- ! 6.Row : number of selective trees per species
- ! 7.Row : relative reduction tending of younger stands
- ! 8.Row : optimum basal area thinning hin\_ob (0 -no, 1- yes);  
and reduction factor ( i.e. 0.9,1.,1.1)
- ! 9.Row : rotation length
- ! 10.Row : first shelterwood cut (age)

Example

```

300. 900. 1200. 1500. ! hoi [cm]
1 1 1 1 1 1 900. 1 10 ! thinning from below + Shelterwood + pine regeneration
20. ! +/- limits [cm]
10 ! [years] thinning interval for Hdom > 1500.
0.2 ! [%] skidding roads reduction
1 0.8 ! opt. Basal area thinning with thinning intensity 0.8
150 200 200 150 0 ! Z-trees
0.15 0.3 0.15 0.15 0. ! [%] tending of plantation (reduction of tree number per species)
140 140 160 160 0 ! age of first shelterwood operation
110 80 120 130 0 ! rotation length

```

Attention: the example is given for 5 species only, row 6- 10 has to enlarge to the actual number of species

## 2. Target management (flag\_mg=33)

### 2.1. Description

Target management (flag\_mg = 33) is a management system which includes thinning at given time steps of simulation **by a specified relative portion of the stem biomass** of the specified species with a thinning type. This management can be combined with natural regeneration (flag\_reg= 30 in the simulation description file).

The forest stand is partitioned into three layers:



- Regeneration layer (cohort variable underst = 1)
- Understorey layer (underst = 2)
- Overstorey layer (underst = 0)

A tree cohort moves from the regeneration layer to the understorey layer, if the DBH of the cohort is greater than or equal 20% of the minimum DBH of the total overstorey. A tree cohort moves from the understorey to the overstorey, if the DBH of the tree cohort is greater than or equal 70% of the minimum DBH of the total overstorey.

This partitioning of the stand allows management and thinning of stands with natural regeneration.

By management control a value for relative stem biomass removal is given ( $V_{red}$ ). Using this value the total amount of stem biomass to be removed is calculated:

$$B_{rem} = V_{red} * (B_{os} + B_{us}) \text{ (thinning type 1,2,3)}$$

$$B_{rem} = V_{red} * B_{reg} \text{ (thinning type 4)}$$

$B_{us}$  – total stem biomass of the understorey cohorts (underst = 2)

$B_{os}$  – total stem biomass of the overstorey cohorts (underst = 0)

$B_{reg}$  – total stem biomass of regeneration cohorts (underst = 1)

The following thinning options are available:

#### Thinning from above (thinning type 3):

- At first stem biomass is removed from the overstorey, using the thinning from above with a Weibull-distribution ( $kb = 1.2$ )
- If  $B_{rem} > B_{os}$  then the amount  $B_{us} - (B_{rem} - B_{os})$  has to remove from the understorey with the Weibull distribution thinning from above.

#### Thinning from below (thinning type 1,2):

- Starts in the understorey using thinning from below with the Weibull –distribution ( $kb = 1.8, 1.6$ )
- If  $B_{rem} > B_{us}$  then  $B_{os} - (B_{rem} - B_{us})$  has to remove from the overstorey with thinning from below
- If there is no understorey thinning starts in the overstorey

#### Tending (thinning type 4):

- Tending is applied only to the regeneration (underst = 1)
- Trees are equally distributed removed from the regeneration cohorts until  $B_{rem}$  is reached

## **2.2. Management control**

### **Example for <name>.man**

! management control file flag\_mg = 33

0 ! mgreg, default/ regeneration: planting of spruce, 10 – pine, 11 – beech, 12 - oak





- heavy thinning from below (thinning type 2):  
Withdrawal the trees of the retired stand with WEIBULL-function and parameter  $k_B = 1.5$  (WENK/ GEROLD) the target value is reached
- moderate thinning from below(thinning type 1):  
Withdrawal the trees of the retired stand with WEIBULL-function and parameter  $k_B = 1.8$  (WENK/ GEROLD) until the target value is reached

### 3.2. *Planting*

Planting is controlled by the following parameters:

a) mreg – defines which species type is planted (row 1)

- 10 - pine
- 11 – beech
- 12 – oak
- 13 - spruce

b) Number of saplings per ha in row 3 for all considered tree species in 4C (at the moment 10).

New types of planting like mixed stands (pine/oak) has to define if necessary (e.g. mixed planting of oak and pine).

**Attention/ important note:**

- If planting is used in the management control file, please, do not use soil vegetation in the simulation control file (flag\_sveg = 0).

### 3.3. *Management control*

**Example for <name>.man**

! management control file flag\_mg = 3

Row 1: 12 ! mgreg ( oak):

Row 2 0 0 0 0 0 0 0 0 0 0 0 0 ! rotation period (not used)

Row 3: 0 0 0 3000 0 0 0 0 0 0 0 0 ! number of plants (3000 oak saplings/ha)

Row 4: 5 ! number of measures

**Comment** The following rows describe the management activities

1. value: year
2. value: target value of stem number
3. value: species type (same number as in species.par)
4. value: thinning method (1,2,3)
- 5.value: thinning from the overstorey (0) or understorey (2)

If planting is used then value 2-4 are zero and the fifth value is 1, that means oak is planted with 3000 saplings/ha (example)



Row 5:	1	136	4	2	2	!	thinning oak	target value 136 stems
Row 6:	1	0	3	3	0	!	felling pine	
Row 7:	6	100	4	3	0	!	thinning oak,	target value 100
Row 8:	26	0	0	0	1	!	planting oak	
Row 9:	31	0	4	3	0	!	felling old oak	

### Important note:

- If the target values of stem number are greater than 0 and less than 1, the value indicates a relative value of the remaining stand. That means, if the target value indicate 0.9 then 90 % of the stem number remains after thinning.
- Do not fell a stand and plant a new one in the same year due to output problems in the veg-files. The best method is to remove 90 percent and planting in one year and in a following year to remove the remaining old trees.