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European beech (*Fagus sylvatica* L.)

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Guidelines for genetic monitoring of

9.2.2 European beech (*Fagus sylvatica* L.)

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1 Executive summary

European beech (*Fagus sylvatica* L.) is a monoecious, stand forming deciduous tree species present throughout most of Europe. This very competitive and shade tolerant species can naturally regenerate in continuous cover silvicultural systems, and is able to conserve the productive capacity of the soil better than many other species. With its high ecological importance and strong wood, this species is a good candidate for genetic monitoring.

These guidelines briefly describe the European beech, its reproduction, environment and threats. They provide guidance on establishing a genetic monitoring plot and recording all field level verifiers.

(a)

(b)

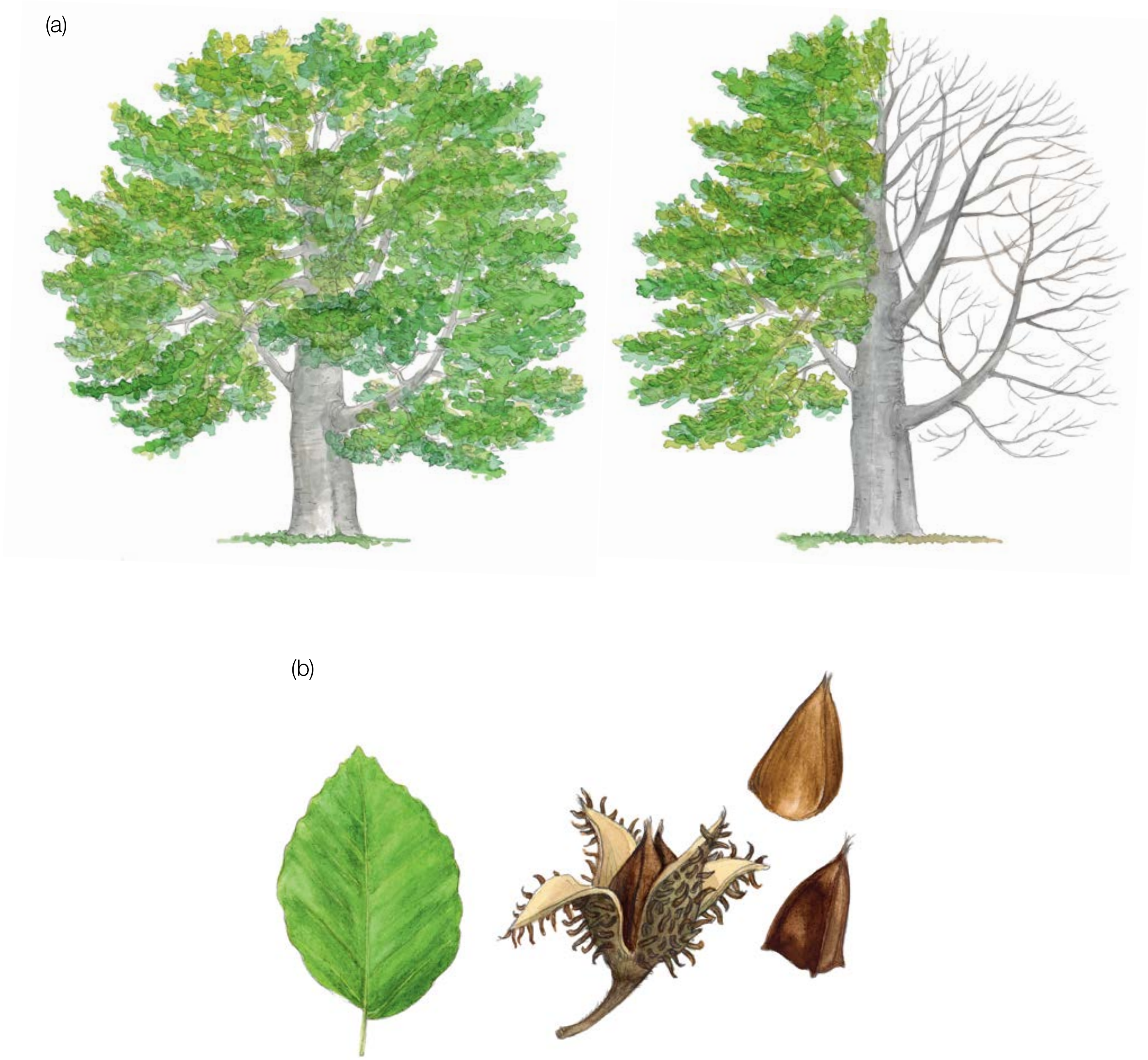


Figure 1: (a) European beech (*Fagus sylvatica* L.) habitus; (b) a leaf and fruit of the European beech.

2 Species description

The European beech (Figure 1a) is a shade tolerant, large deciduous tree reaching 30-40 m, in some locations up to 50 m [1]. It has a long-life span, up to 250 to 300 years, although it is typically harvested at 80 to 120 years [1, 2]. In contrast to many other tree species, it maintains a high growth rate into maturity [2]. The bark is thin, smooth, silver-grey and very characteristic of beech [1, 2]. Light green ovoid leaves (Figure 1b) with silky hairs turn to shiny dark green in the late spring [2]. They have six or seven parallel veins on each side of the main one. They have no lobes or peaks and have a short stalk. In the winter, beech is easily identifiable by sharply pointed long and slender buds not pressed against the twigs [4].

Where sympatric with *Fagus orientalis* Lipsky, hybridisation may occur between the two species [1].

3 Reproduction

Wind pollinated beech is monoecious [1, 2]; separate male and female flowers are borne on the same branches emerging from the same bud. The male flowers are borne in small catkins. It starts reproducing very late, in forest stands when it is 40-50 years old. A full mast year normally occurs every 5 to 8 years, sometimes in larger intervals, usually following hot summers of the previous year [1, 3].

Start of budbursting (flushing) varies from population to population and from year to year; budbursting that occurs from the end of March to May in central Europe is closely followed by flowering from April to May. Once the female flowers have been pollinated by wind, they develop into clearly visible fruits; nuts are sharply tri-angled (Figure 1b) and are borne singly or in pairs in soft-spined cupules [1, 2, 3]. They ripen and fall off the tree in September to November [3]. Beech seed has strong dormancy [3].

European beech exhibits properties of a climax species. Dispersal and natural regeneration are efficient, and beech is very competitive, especially in shady conditions [1].

4 Environment

European beech grows throughout central and western Europe, reaching southern Scandinavia in the north and Sicily in the south [1, 2]. Because it requires a humid atmosphere with precipitation well distributed throughout the year, its distribution is limited by high summer temperatures, drought and low moisture availability, as well as continentality in north-western Europe [1]. It tolerates winter cold but is sensitive to late spring frosts, which limits its distribution in the northern boreal regions [1]. It thrives in moderately fertile soils, calcified or lightly acidic, but does not like waterlogged or compacted soils [1]. It is a stand forming tree species [2].

5 Threats

European beech is a hardy species. Still, spring frosts often damage young trees or flowers appearing at the same time as leaves. Old trees may get a 'red heart' which reduces stability and timber value. *Mikiola fagi* Hartig, gall midge can kill young beech trees and reduce increment in heavily attacked trees. Beech is also among the susceptible hosts of *Phytophthora ramorum* Werres, De Cock & Man, a quarantine fungus. *Anoplophora chinensis* Forster, the citrus long-horned beetle and *Anoplophora glabripennis* Motschulsky, the Asian long-horned beetle, both originating from Asia, are an emerging threat for beech [5].

6 Plot establishment and maintenance

European beech is a stand forming tree species which can form pure or mixed forest stands with silver fir, Norway spruce and other tree species [1].

A forest genetic monitoring plot consists of 50 reproducing trees with a Diameter at breast height (DBH) of over 15 cm and the minimum distance of 30 m between any two trees. If a tree is flowering, it is regarded as a reproducing tree. DBH and social class can be used as a proxy to identify a reproducing tree if the plot is being established outside of the flowering season, relying on the expertise of the local forester. During plot installation, trees should be labelled and coordinates of all trees taken. At the same time DBH can be measured and samples for DNA extraction taken.

Equipment needed:

- a device for distance measurement (a pair of range-finding binoculars is recommended),
- a compass,
- a paint and a brush or spray for marking trees,
- a tree calliper for DBH measurements, and
- a GPS device that is precise enough and allows saving trees' coordinates.

6.1.1 Plot establishment

6.1.1.1 Selection of the centre of the plot

The general procedure for random plot site selection consists of the following steps (Figure 2a):

- Random selection of a point (green dot) on a map along the forest road or path, which runs along the stand,
- Drawing a line that is approximately perpendicular to the road from the randomly selected point on a road,
- Random selection of one point on the line (red dot) – this point represents the centre of the forest genetic monitoring plot.

The minimum distance between the selected central point and stand border is approximately 150 m. If the selected central point doesn't meet this demand, a new point must be selected following the protocol described above.

(a)

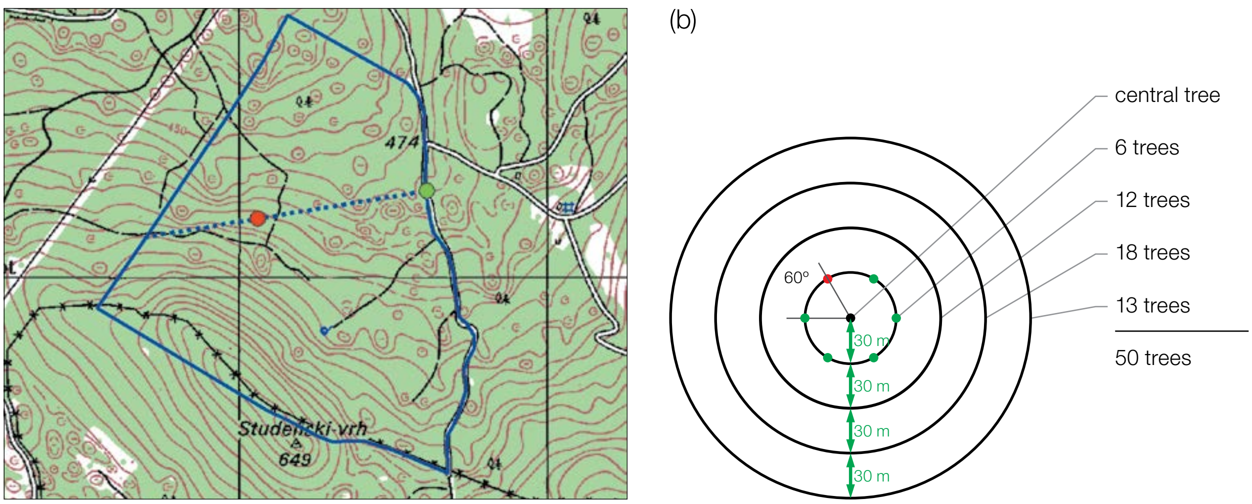


Figure 2: Random selection of the centre of the forest genetic monitoring plot (a); Selection of trees in concentric circles around previously selected central tree with an increasing radius of 30 m (b).

Instead of the procedure described above, tools for creating random points in GIS software can also be used.

The selected point's coordinate should be saved into a GPS device that will be used in the field.

6.1.1.2 Plot installation in the field

In the field, the closest reproducing tree to the saved GPS coordinate becomes the centre of the monitoring plot and is marked with number 1.

Other trees are selected in concentric circles around the central tree with an increasing radius of 30 m (Figure 2b). The first tree in each circle should be selected randomly, which can be done in different ways: by using a random azimuth (Table 1) observed from the central tree, by following the direction of the second hand on an analogue watch or any other approach that allows for objective selection. The remaining trees in each circle are selected by an appropriately enlarged azimuth to assure a minimum distance of 30 m between any two trees:

- +60° for the first circle,
- +30° for the second circle,
- +20° for the third circle,
- +15° for the fourth circle.

If it is not possible to find six, 12 and 18 trees in the inner three circles (Figure 2b), additional trees are selected in the outermost circle.

Table 1: Randomly generated azimuths that can be used for selection of the first tree in each circle.

108	15	186	35	178	29	305	351	44	150
232	23	160	141	112	292	216	83	245	214
63	65	345	234	95	78	279	323	40	236
201	313	275	144	182	68	268	289	185	92
356	177	93	1	145	198	287	251	224	142

6.1.1.3 Labelling of trees

Each selected tree must be marked with a corresponding number and preferably a band painted around the trunk to aid the visibility of the trees from all directions. Mark the central tree (number 1) with two or more bands to differentiate it from other trees (Figure 3a). It is recommended to paint the number on the side of the tree that is pointing away from the central tree, as this helps in locating the central tree, particularly from the outer rings of the plot (Figure 3b).

Figure 3: a) The central tree on the genetic monitoring plot is marked with multiple bands to differentiate it from other trees; b) numbers are painted on selected trees so that they point away from the central tree.

6.2 Establishment of natural regeneration subplots

The establishment of natural regeneration (NR) subplots should be carried out during germination after a strong or massive fructification event.

Natural regeneration centres from the last mast year should be surveyed in the field and their locations logged (GPS coordinates, number of the tree which is next to an NR centre). From all logged regeneration centres, 20 should be chosen randomly for plot installation. If 20 or fewer natural regeneration centres are present, all should be used.

Inside each selected natural regeneration centre a $1m^2$ plot is to be installed and marked with metal rods. Metal rods should be driven into the ground at each corner of the subplot as deep as possible to prevent them from being removed by animals. Tips of the metal rods should be painted to aid their visibility.

6.3 Plot maintenance

6.3.1 General maintenance

Tree markings and subplot markings must be checked periodically (every two years) and repaired if needed.

6.3.2 Replacement of trees

If a monitored tree dies or is cut due to management, it must be replaced. The nearest suitable tree to the dead one should be chosen considering that the distance requirement of 30 m to the nearest monitored tree is fulfilled. Otherwise a tree from the periphery (preferably in the outer circle) of the FGM plot is to be selected. The replacement tree is marked with the next available number higher than 50, i.e. 51, 52, 53, etc. to positively differentiate it from the original 50 selected trees.

If the crown is damaged due to, for example, wing break, ice or snow break but continues to fructify, the tree is kept for monitoring. If the damage is too severe and fructification is not expected anymore, the monitored tree must be replaced. The cause of damage needs to be recorded, as the damage can affect the values recorded for field verifiers and background information.

7 Recording of verifiers and background information

Verifiers and background information are periodically recorded on the monitoring plot. Verifiers are used to monitor the population's genetic properties and its adaptation to environmental changes and/or management, while background information is recorded to assist interpretation of the verifiers.

Higher levels of verifiers (standard, advanced) must also include recording on all the preceding levels (basic, standard). This is not necessary for recording of background information.

Table 2: List of verifiers and background information with a short description and observation frequency to be recorded during fieldwork at the beech monitoring plots.

	Name	Basic level	Standard level	Advanced level
Verifiers	Mortality / survival	Adult trees: Counting of the remaining marked trees every 10 years and after every extreme weather event/disturbance	Same as basic level	Same as basic level
		Natural regeneration: /	Counting of remaining seedlings on the natural regeneration subplots, twice per decade	Same as standard level
	Flowering	Stand-level estimate, every year	Individual tree level observation, during two major flowering events per decade, ideally equally spaced *	Individual tree level observation, during two major flowering events per decade, ideally equally spaced *
	Fructification	Stand-level estimate, every year	Individual tree level observation, the same year as the assessment of the flowering at the standard level (regardless of the fructification intensity) *	Counting of fruit, the same years as the assessment of flowering at the advanced level, regardless of the fructification intensity * Seeds are also collected for laboratory analyses every assessed fructification event
	Natural regeneration abundance	Stand-level estimate, every year	Counting of seedlings in the 1st and 6th years after every assessed fructification event	Counting of seedlings in the 1st, 6th, 11th, and 16th years after every assessed fructification event
Background information	DBH class distribution	/	Measurement every 10 years	Same as standard level
	Height class distribution	/	Measurement every 10 years	Same as standard level
	Budburst	/	Individual tree level observation, every 5 years	Individual tree level observation, every year
	Senescence	/	Individual tree level observation, every 5 years	Individual tree level observation, every year
	Flowering synchronisation	/	/	Individual tree level observation, during each assessed major flowering event

* Ideally at least one major fructification event should be assessed per decade. However, a major flowering event does not necessarily lead to a major fructification event. If no major fructification event follows the assessed flowering event, assessment of both flowering and fructification needs to be repeated during the next major flowering event, regardless of the time passed between successive major flowering events. Basic level observations are used to identify major flowering and fructification events.

7.1 Protocols for recording of verifiers

7.1.1 Mortality / survival

Mortality describes the mortality of adult trees and natural regeneration. Its counterpart survival stands for trees that are still alive since the previous assessment. Survival is calculated as 1 – Mortality.

7.1.1.1 Adult trees: Basic, standard and advanced level

Verifier for mortality of adult trees. It is estimated by counting the remaining alive marked trees every 10 years and after every extreme weather event/disturbance. Mortality is the difference between the initial number of marked trees and the trees remaining alive of the original 50.

7.1.1.2 Natural regeneration: Standard and advanced level

Mortality of natural regeneration is calculated from the verifier Natural regeneration abundance. Mortality is the difference between the initial number of NR plants and the plants remaining alive at the time of the next counting.

For each round of assessment, the NR is counted first in the year of germination and then again after 5 years at the standard level, while at the advanced level the counting is also performed after 10 and 15 years. Assessment of NR abundance is carried out twice per decade, ideally approximately every five years.

7.1.2 Flowering

This verifier describes the flowering intensity and the proportion of trees thus affected. It can be recorded in April to May in central Europe.

7.1.2.1 Basic level

This verifier is recorded every year at the stand level. Recording is carried out when flowering is in full progress. The estimate of average condition is provided after a walk throughout the monitoring plot. Two scores are given, one for flowering intensity, expressed as the average proportion of the crown flowering, and one for the proportion of flowering trees in the stand.

Code	Flowering intensity at the stand level	Average proportion of crown flowering (%)
1	No flowering: No or only occasional flowers appearing on trees	0 – 10
2	Weak flowering: Some flowers appearing on trees.	> 10 – 30
3	Moderate flowering: Moderate number of flowers appearing on trees.	> 30 – 60
4	Strong flowering: Abundant number of flowers on trees.	> 60 – 90
5	Massive: Huge number of flowers on trees.	> 90

Code	Proportion of trees in the stand with the given flowering intensity stage (%)
1	0 – 10
2	> 10 – 30
3	> 30 – 60
4	> 60 – 90
5	> 90

7.1.2.2 Standard level

This verifier is recorded during two major flowering events per decade, ideally equally spaced in time from one another. It is recorded at an individual tree level on all 50 monitored trees. A major flowering event is when at the basic level flowering intensity is strong or massive (code 4 or 5) and the proportion of trees with the given flowering intensity is above 60% (code 4 or 5). Recording is carried out when flowering is in full progress. One score is provided for each tree.

Code	Description	Proportion of the crown flowering (%)
1	No flowering: No or only occasional flowering appearing on a tree.	0 – 10
2	Weak flowering: Some flowers appearing on a tree.	> 10 – 30
3	Moderate flowering: Moderate number of flowers on a tree.	> 30 – 60
4	Strong flowering: Abundant number of flowers on a tree.	> 60 – 90
5	Massive: Huge number of flowers on a tree.	> 90

7.1.2.3 Advanced level

This verifier is recorded during two major flowering events per decade, ideally equally spaced in time from one another. It is recorded at an individual tree level on all 50 monitored trees. A major flowering event is when at the basic level flowering intensity is strong or massive (code 4 or 5) and the proportion of trees with the given flowering intensity is above 60% (code 4 or 5). On average, two visits to the plot are needed; the first one early enough to observe the early stages of flowering and the second one when flowering is in full progress.

Three scores are provided for each tree: female flowering stage, male flowering stage and the proportion of the crown flowering. The proportion of the crown flowering refers to the total number of flowers (male + female) on the tree. For a graphical representation of flowering stages, see Figure 4.

Code	Female flowering stage
1	Female flower fully developed
2	Formation of fruit or nuts fully formed but nuts shells not yet open

Code	Male flowering stage
1	Elongated peduncle – closed flowers (green)
2	Anthers releasing pollen (yellow)
3	Empty anthers (pollen released) (brown)

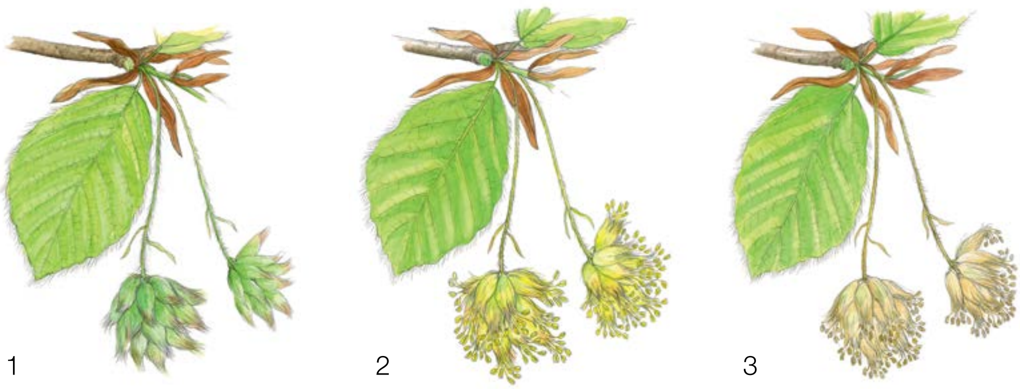
Code	Proportion of the crown flowering (%; male and female flowering together)
1	0 – 10
2	> 10 – 30
3	> 30 – 60
4	> 60 – 90
5	> 90

The background information Flowering Synchronisation can be estimated from the scores for female and male flowering recorded by this verifier.

(a)

1 2

(b)



1 2 3

Figure 4: Picture guide for description of female (a) and male flowering (b) stages for the advanced level verifier Flowering.

7.1.3 Fructification

This verifier describes the presence of fructification and its abundance. Data for this verifier should be collected during fructification, in August to October in central Europe.

7.1.3.1 Basic level

This verifier is recorded every year at the stand level. The estimate of average condition is provided after a walk throughout the monitoring plot. Two scores are given, one for fructification intensity and one for the proportion of fructifying trees in the stand.

Code	Fructification intensity at the stand level	Average proportion of the crown bearing fruit (%)
1	No fructification: No or only occasional fruit appearing on trees	0 – 10
2	Weak fructification: Some fruit appearing on trees	> 10 – 30
3	Moderate fructification: Moderate amount of fruit appearing on trees	> 30 – 60
4	Strong fructification: Abundant amount of fruit appearing on trees	> 60 – 90
5	Massive: Huge amount of fruit appearing on trees	> 90

Code	Proportion of trees in the stand with the given stage of fructification intensity (%)
1	0 – 10
2	> 10 – 30
3	> 30 – 60
4	> 60 – 90
5	> 90

7.1.3.2 Standard level

This verifier is recorded during the same years as the assessment of the flowering at the standard level (regardless of the fructification intensity). It is recorded at an individual tree level on all 50 monitored trees. Recording is carried out before fruits start falling. One score is provided for each tree.

Ideally, one major fructification event should be captured following observations of major flowering events per decade. However, a major flowering event does not necessarily lead to a major fructification event. If no major fructification event follows the assessed flowering event, then the assessment of both flowering and fructification needs to be repeated during the next major flowering event, regardless of the time passed between successive major flowering events. Basic level observations are used to identify major fructification events. A major fructification event is when at the basic level fructification intensity is strong or massive (code 4 or 5) and the proportion of trees with the given fructification intensity is above 60% (code 4 or 5).

Code	Fructification intensity	Proportion of the crown fructifying (%)
1	No fructification: No or only occasional fruit appearing on a tree.	0 – 10
2	Weak fructification: Some fruit appearing on a tree.	> 10 – 30
3	Moderate fructification: Moderate amount of fruit appearing on a tree.	> 30 – 60
4	Strong fructification: Abundant amount of fruit appearing on a tree.	> 60 – 90
5	Massive: Huge amount of fruit appearing on a tree.	> 90

7.1.3.3 Advanced level

This verifier is recorded at an individual tree level on all 50 monitored trees during the same years as the assessment of flowering at the advanced level, regardless of the fructification intensity. Recording is carried out before fruits start falling. One score is provided for each tree. Simultaneously, seed is collected for seed and genetic analysis for the advanced level verifiers and background information.

Ideally, one major fructification event should be captured following observations of major flowering events per decade. However, a major flowering event does not necessarily lead to a major fructification event. If no major fructification event follows the assessed flowering event, assessment of both flowering and fructification needs to be repeated during the next major flowering event, regardless of the time passed between successive major flowering events. Basic level observations are used to identify major fructification events. A major fructification event is when at the basic level fructification intensity is strong or massive (code 4 or 5) and the proportion of trees with the given fructification intensity is above 60% (code 4 or 5).

The verifier is recorded by counting fruits using binoculars. The average of three rounds of counting is reported. Each round of counting consists of the number of fruits that the observer counts in 30 seconds. For all trees, the same part of the crown should be investigated. Once the observation part of the crown part is selected, the same one should be selected for every subsequent monitoring of this verifier. The upper third of the crown is preferred to the bottom and middle part for counting.

Two values are recorded; the number of fruits and the part of the crown monitored.

Number of fruits counted in 30 seconds (average of 3 rounds)
X

Code	Part of the crown monitored
1	Bottom
2	Middle
3	Top

7.1.4 Natural regeneration abundance

This verifier describes the presence and abundance of natural regeneration (NR) at the monitoring plot.

7.1.4.1 Basic level

The verifier is recorded at the stand level every year in the autumn. Expert opinion is used for estimation considering the situation over the whole monitoring plot. Two values should be recorded, one for ‘new NR’ (seedlings that germinated the same year as the assessment is carried out) and one for ‘established NR’ (NR older than ‘new NR’).

Code	Description: new natural regeneration (current-year seedlings)
1a	There is no or very little new natural regeneration on the monitoring plot
2a	New regeneration is present in sufficient quantity on the monitoring plot

Code	Description: established natural regeneration (saplings older than 1 year)
1b	There is no or very little established natural regeneration on the monitoring plot
2b	Established regeneration is present in sufficient quantity on the monitoring plot

7.1.4.2 Standard level

This verifier is recorded by counting seedlings in the 1st autumn after every assessed fructification event (the year of the fructification event is regarded as year 0) and 6th autumn after the fructification event.

Counting of seedlings:

After the establishment of NR sublots all beech seedlings present at each of the 20 NR sublots must be counted. Any older beech saplings that are present on the NR subplot must not be included. During the next counting round, only saplings of the appropriate age must be counted – i.e., in the 6th year, five-year old saplings.

Number of seedlings counted on a subplot
X

Mortality/survival of natural regeneration is calculated from the values recorded for this verifier.

For subplot establishment see 6.2 Establishment of natural regeneration subplots.

7.1.4.3 Advanced level

This verifier is recorded by counting seedlings at each of the 20 NR subplots in the 1st autumn after every assessed fructification event (the year of the fructification event is regarded as year 0) and 6th, 11th, and 16th autumn after this fructification event.

Table 3: Timeline of natural regeneration abundance (NR) assessment. In this example, the first fructification event takes place in the second year of the monitoring decade, and the second assessed fructification event five years later, i.e. in the 7th year of the monitoring. Twenty new NR subplots are established after each assessed fructification event. Monitoring of NR abundance on each set of 20 NR subplots is carried out every five years. The fructification events corresponding to the assessed NR and timelines of the assessment activities are shaded in the same colour. After the final round of counting of seedlings, monitoring of NR abundance on the respective set of NR subplots is stopped and the respective NR subplots disestablished. S – standard level; A – advanced level.

Year of monitoring	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Fructification event		•					•							•					•				
NR assessment from the 1st assessed fructification event [yrs]		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
NR subplot establishment			SA																				
NR abundance counting			SA					SA					A					A					
NR assessment from the 2nd assessed fructification event [yrs]							0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NR subplot establishment								SA															
NR abundance counting								SA					SA					A					A

Mortality/survival of natural regeneration is calculated from the values recorded for this verifier.

For subplot establishment see 6.2 Establishment of natural regeneration subplots and for counting 7.1.4.2 Standard level.

7.2 Protocols for recording of background information

7.2.1 DBH class distribution

7.2.1.1 Standard and advanced level

DBH is recorded on an individual tree level on all 50 monitored trees every 10 years. DBH is the trunk diameter at 1.30 m, i.e. approximately at an adult's breast height. If a tree has more than one trunk, measure all of them and record the average (but try to avoid trees with many small trunks). Note that the tree is a multi-trunk one in the notes and include the number of trunks measured. If the tree is leaning, measure DBH perpendicular to the tree trunk. DBH can be measured in two ways:

1) using a calliper, in which case you need to measure two perpendicular diameters and take the average
2) measure the circumference of the tree and compute the diameter from that value (i.e. divide by π, ~3.14 or use a pi-meter)

The DBH is recorded in cm. The same method must be applied for every subsequent measurement.

7.2.2 Height class distribution

7.2.2.1 Standard and advanced level

Height is recorded on an individual tree level on all 50 monitored trees every 10 years. Height is measured from the ground to the tallest part of the crown, ideally using a clinometer or hypsometer (e.g. vertex). Height is recorded in meters to one decimal place. If the crown is damaged, this must be recorded as well as the reason for this in the notes.

7.2.3 Budburst

Budburst describes the process of budbursting (flushing). Recording of this background information is only carried out at the standard and advanced levels. Data for this background information should be collected from the end of March (in central Europe) until all monitored trees have reached fully developed leaves.

7.2.3.1 Standard level

At standard level, budburst is recorded on an individual tree level on all 50 monitored trees every five years. We are looking for the initiation of budbursting (stage 3) and the end of budbursting (stage 5). The observations cease when all the trees have reached stage 5. Usually, six visits will be needed. For each tree, two estimates are given: budbursting stage and proportion of the crown budbursting. For a graphical representation of budbursting stages see Figure 5.

Code	Stage of budbursting
1	Dormant winter bud
2	Buds swollen and elongated
3	Buds begin to burst (first green is visible)
4	Folded and hairy leaves begin to appear; individually visible folded and hairy leaves
5	Leaves fully unfolded, smooth and bright

Code	Proportion of the crown with a given stage of budbursting (%)
1	> 0 – 33
2	> 33 – 66
3	> 66 – 99
4	100

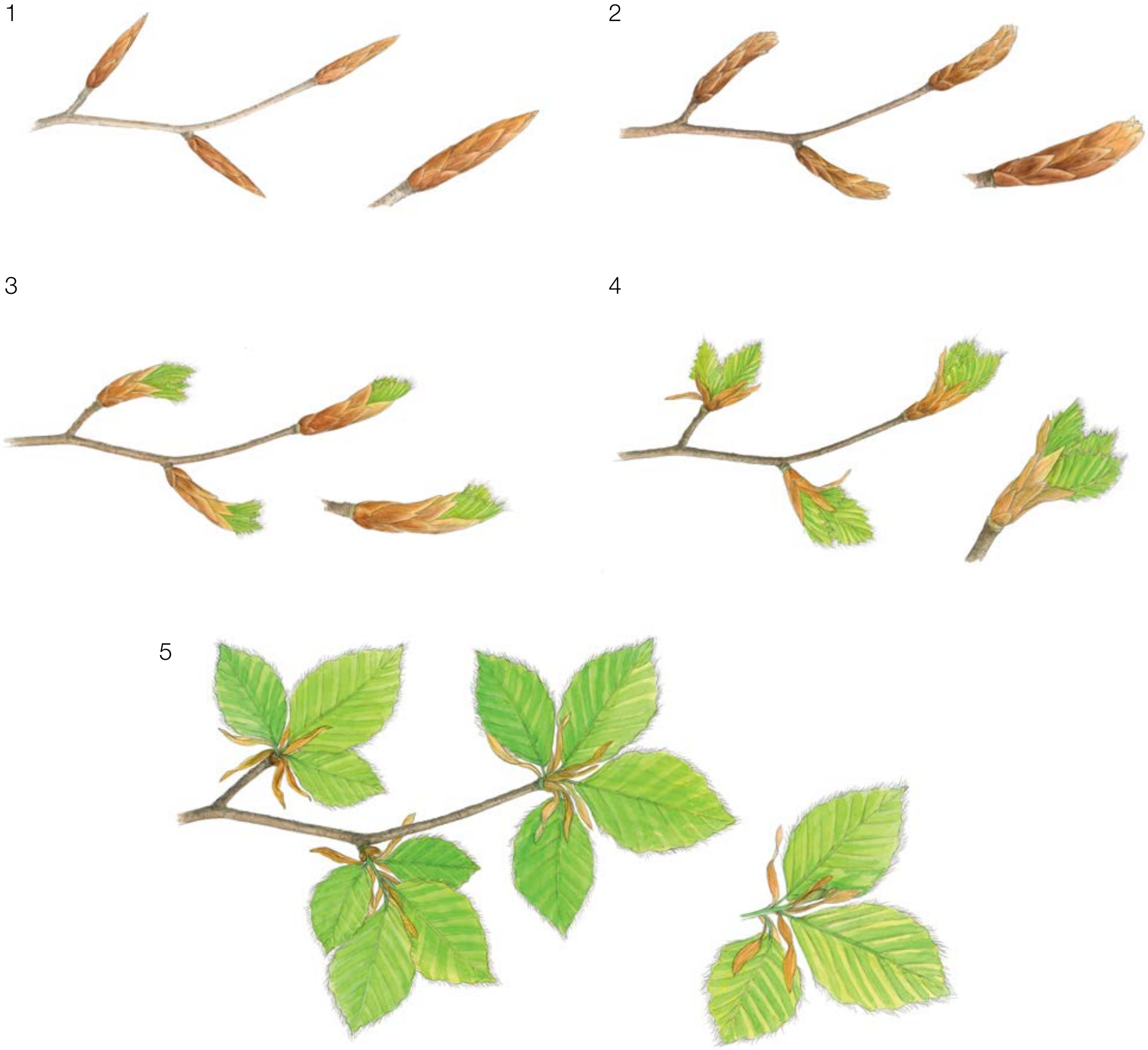


Figure 5: Picture guide for description of budburst (flushing) for the standard, and advanced level background information Budburst.

7.2.3.2 Advanced level

At advanced level, budburst is recorded on an individual tree level on all 50 monitored trees every year. in the same way as at the standard level. For details see 7.2.3.1 Standard level.

7.2.4 Senescence

Senescence describes the process of senescence. Recording of this background information is only carried out at the standard and advanced levels.

7.2.4.1 Standard level

At standard level, senescence is recorded on an individual tree level on all 50 monitored trees every five years. We are looking for stage 3, when leaves are yellow and do not photosynthesise anymore. Observations stop when all the trees have reached stage 3. Usually, two (2) visits to the plot will be needed. For each tree, two estimates

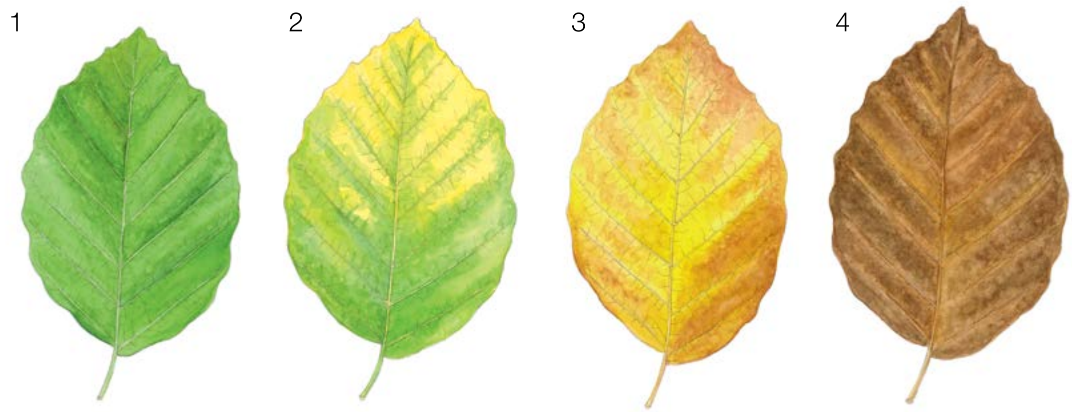


Figure 6: Picture guide for description of senescence for the standard and advanced level background information Senescence.

are given: stage of senescence and proportion of the crown senescing. For a graphical representation of stages of senescence, see Figure 6.

Code	Stage of senescence
1	Leaves are green
2	Leaves are green changing to yellow (greenish yellow)
3	Leaves are yellow changing to brown (brownish)
4	Leaves are brown / shed

Code	Proportion of the crown with a given stage of senescence (%)
1	> 0 – 33
2	> 33 – 66
3	> 66 – 99
4	100

7.2.4.2 Advanced level

Senescence is recorded on an individual tree level on all 50 monitored trees every year in the same way as at the standard level. For details, see 7.2.4.1 Standard level.

7.2.5 Flowering synchronisation

7.2.5.1 Advanced level

Flowering synchronisation is monitored only at the advanced level, and is based on the data collected for the verifier Flowering. It is used to determine whether male and female flowering times occur simultaneously within the monitored stand.

For plot establishment use form 'FGM Plot description'

For verifiers recording use 'Form for recording field level verifiers within FGM'

For background information recording use 'Form for recording field level background information within FGM'

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