13th National Forest Inventory of Finland (NFI13) – Field manual

FOREWORD

This document is an unofficial translation of the original NFI13 field manual which is in finnish.

The 13th National Forest Inventory (NFI13) was launched in the summer of 2019. As in the previous three inventories, field data will be collected over five years by measuring a set of plots from the whole country every year. The exceptions are, as before, Åland and Upper Lapland (Enontekiö, Inari and Utsjoki) and the timing of measurements will be decided later.

In the previous inventory, NFI12, the proportion of permanent clusters was increased from 20% to 60%. In NFI13, all of these are remeasured, and even half of the new clusters are established as additional permanent clusters. Thus, in NFI13, the proportion of temporary clusters is only 20% of all clusters. In the future, the growth of the stand can be calculated more reliably than before on the basis of permanent plots, and the suitability of the data e.g. monitoring the effects of the new Forest Act will improve.

Despite the change in cluster types, the sampling setup is the same as in NFI12. The number of plots is slightly smaller than before, when some of the plots are not measured on the old permanent clusters in Central Finland.

The description of forest stands and tree strata continues as in NFI12. What is new is that, especially to identify uneven-aged forest management, but also as support for the description of cuttings, soil preparations and forest regeneration, data from notification of forest use is searched in advance for the plots.

In the tree measurements, the fixed-radius plots introduced in the previous inventory are used. Workload is reduced so that the radius of the plot is now 4.00 meters for trees in 45-94 mm in diameter (instead of 5.64 meters used in previous NFI). Otherwise, the plot remains the same, trees with diameter of at least 95 mm have a radius of 9.00 m, and trees less than 45 mm are measured on a relascope plot with a factor 1.5 relascope.

Dead wood is measured as before in the old permanent plots with a radius of 7 meters. What is new is that the dead trees were mapped in the previous measurement, and now more detailed information is recorded about the change in decaying trees. Usable dead trees are measured in the same way as living trees in all plots, whereas in the previous inventory the measurement was made only in permanent plots.

What is also new is that the inventory collects information on the paths and routes related to recreational use of forests, as well as the structures and services made for recreational use.

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Abbreviations

LUC 1–3	measured/estimated only on stands with this land use class
Dev.class: 1–3	measured/estimated only in these development classes
petlands	measured/estimated only on peatland site types
drained	measured/estimated only on drained peatland sites
r=9	measured/estimated on fixed-radius plot with the radius of 9 m (similarly r=7,00, r=20 and r=30)
Perm.plots	measured/estimated only in permanent sample plots
Temp.plots	measured/estimated only in temporary sample plots
P-perm.	measured/estimated only in old permanent sample plots
P- and U-perm.	measured/estimated only in remeasurements of permanent plots
center point	measured/estimated only in/for the sample point stand

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1 DESCRIPTION OF FIELD WORK

Sampling units

The clustering principle of the plots to be measured is shown in Figure 1. The sampling regions (Appendix 1) are the same as in NFI12. In the summer of 2021, a normal sample, i.e. one-fifth of the NFI13 clusters, will be measured in all regions. No measurements will be made in Åland and Northernmost Lapland in 2021.

In NFI12, two temporary and two new permanent clusters were measured per one old permanent cluster. In NFI13, each old permanent cluster (P-permanent) is surrounded by two permanent clusters measured first time in NFI12 (U-permanent) and two new clusters, one of which is established as a new permanent cluster (X-permanent) and the other is a temporary cluster. The clusters consist of sample plots at the vertex and / or sides of a right angle opening to southeast or northwest (Figure 1).

In southern Finland, the old permanent clusters have 10 plots with a distance of 250 m between the plots. The other clusters have 8 plots and the distance between the plots is 300 m. The area represented by the cluster group is 12 x 12 square kilometers. The theoretical area represented by one plot is 343 hectares.

In Central Finland, all clusters have 9 sample plots with a distance of 300 m. Thus, some of the plots of old permanent clusters are now left unmeasured. The area represented by the cluster group is 14 x 14 square kilometers. The theoretical area represented by one plot is 436 hectares.

In the southern part of Northern Finland (Kainuu and Northern Ostrobothnia excl. Kuusamo), the old permanent clusters have 11 plots with a distance of 300 m. The other clusters have 8 plots and the distance of the plots is 300 m. The area represented by the cluster group is 14 x 14 square kilometers. The theoretical area represented by one plot is 456 hectares.

In southern Lapland (incl. Kuusamo), the old permanent clusters have 11 plots with a distance of 300 m. The other clusters have 10 plots with a spacing of 300 m. The area represented by the cluster group is 20 x 20 square kilometers. The theoretical area represented by one plot is 784 hectares.

Most of the stand and tree stratum variables are estimated and measured by stands (i.e. by forest compartments). A stand is a homogenous area in respect to the site, growing stock, implemented forestry operations, proposed future forest management and ownership boundaries. In NFI, stand variables should be collected as an estimated mean of the nearest quarter hectare. However, some stand variables (e.g. soil variables) are estimated only in the tally tree plot (i.e. inside 9 m plot radius).

The tally tree plot has been slightly changed compared to the previous inventory. The radius of the plot is 4.00 meters for trees with 45–94 mm (5.64 meters in NFI12) and 9.00 meters for trees with at least 95 mm. Trees less than 45 mm are measured from a relascope plot with a factor of 1.5. The selection of sample trees from tally trees in the fixed-radius plot is made

at regular intervals on the basis of the cumulative basal area. The sampling interval is 15 m2 / ha in South Finland and 10 m2 / ha in northern Finland. Of the trees under 45 mm, every tenth in southern Finland and every seventh in North Finland is selected as a sample tree.

Field team

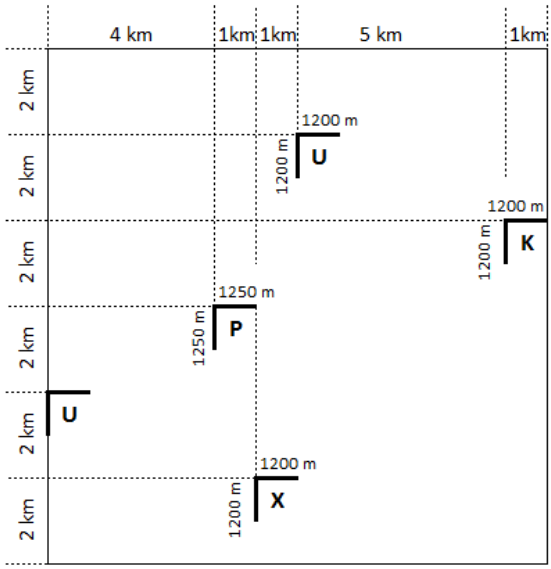
The field team consists of a team leader and an assistant. The tasks of the team leader include planning and organizing the work in an appropriate way. In the plot, the team leader locates the center of the plot, defines the stand to be described, and makes a stand description. The team leader must ensure that all measurements and classifications are performed in accordance to the instructions.

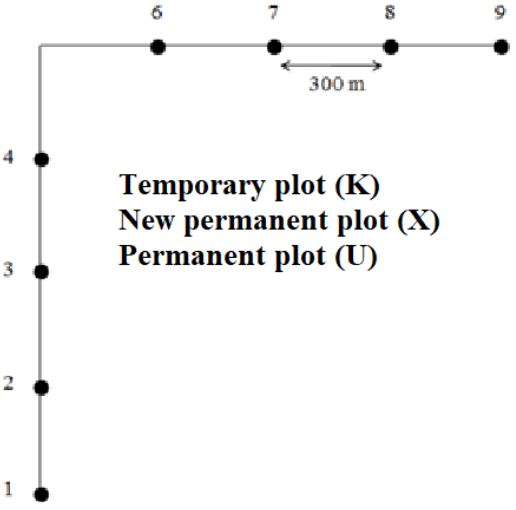
Assistant's tasks include measuring tally and sample trees. Recording of the number of seedlings in seedling stands are part of the assistant's duties, however, so that the team leader instructs in the selection of seedlings in cases of doubt.

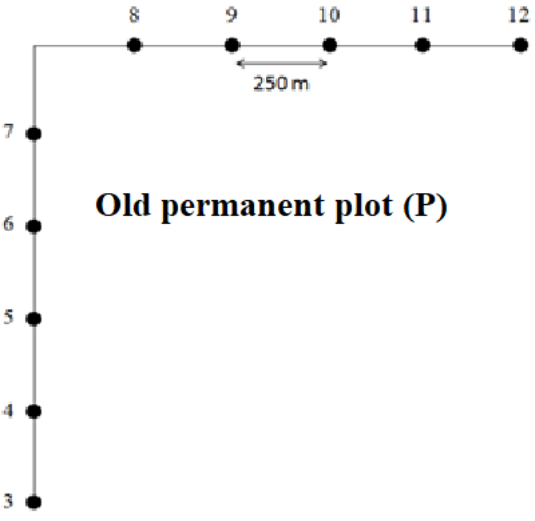
The normal way of sharing the tasks is described above, but it is not necessary to follow it exactly. Sample trees, basal areas, number of seedlings and decaying wood can be measured by any team member who is free to do it.

Figure 1. NFI13 clusters in Southern Finland, Central Finland, Southern part of Northern Finland and Southern Lapland.

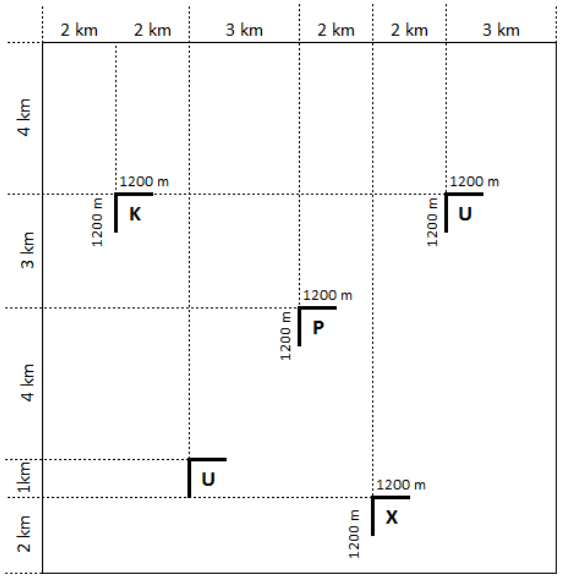
Southern Finland

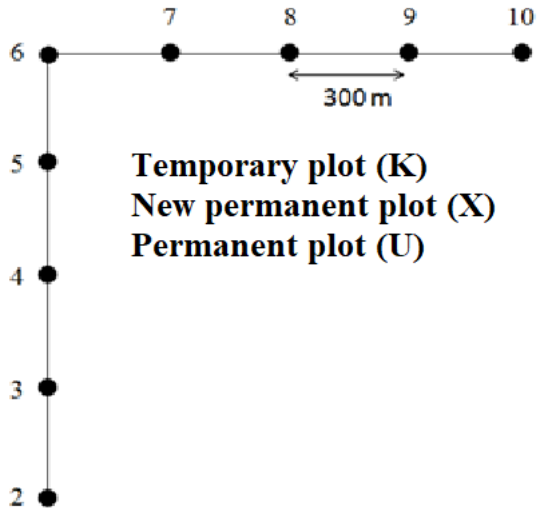


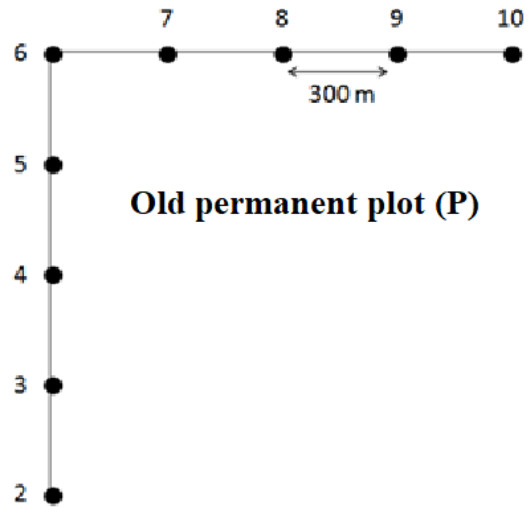




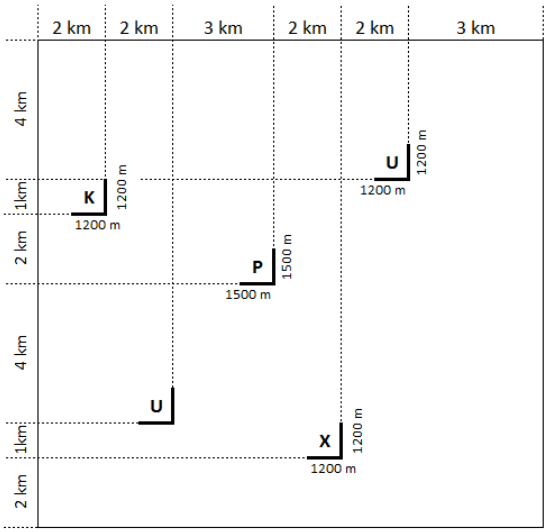
Central Finland

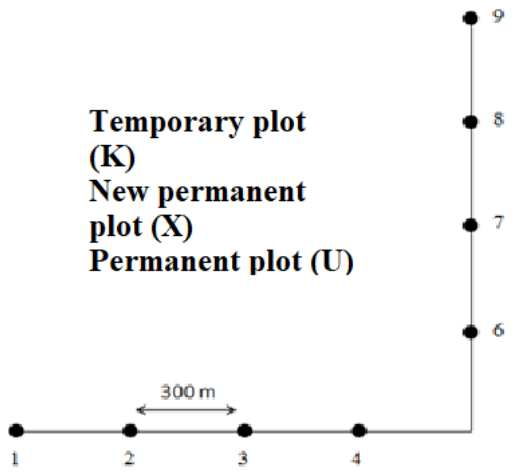


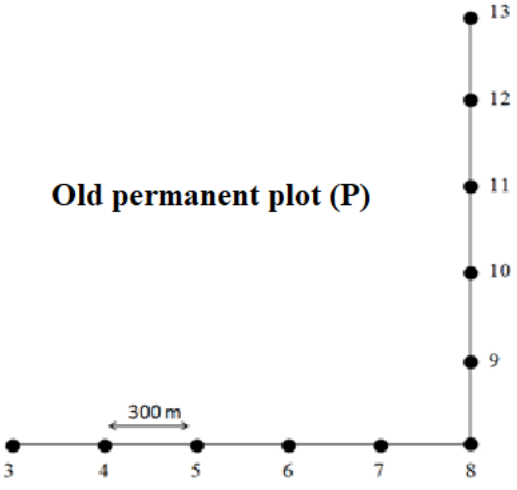




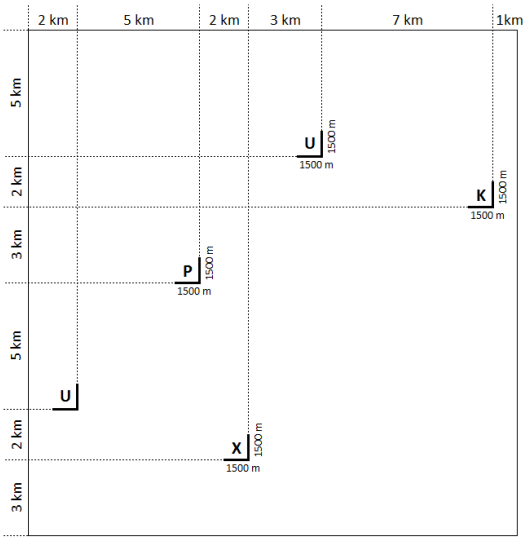
Southern part of North Finland

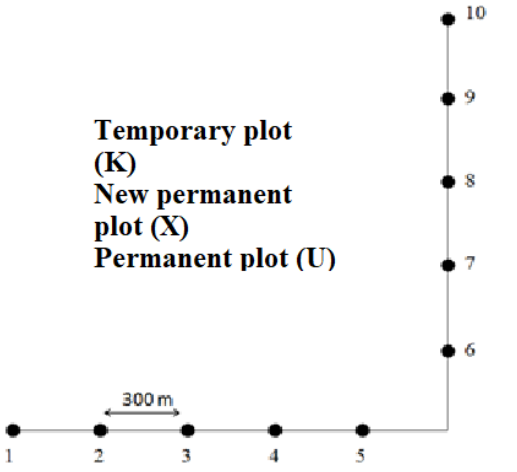


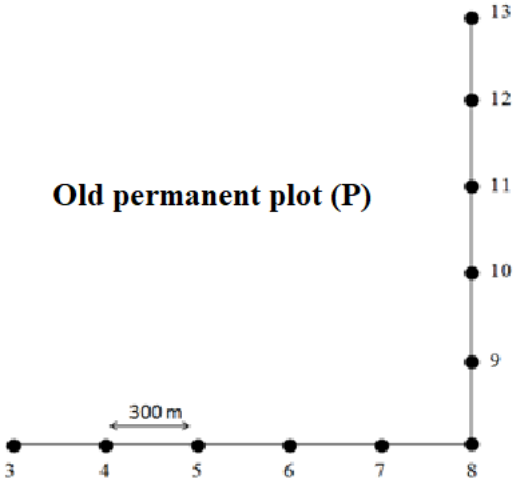




Sourthern Lapland







Locating sample plots

Locating the sample plots includes two separate functions 1) navigation to the plot and placement of the center point, and 2) collection and storage of location data of the center point. Depending on the function and the site types of the plots, two different types of satellite positioning devices (GNSS device) are used for locating. The handheld locators are used as lighter and less accurate devices. The handheld locators are either Topcon FC336 or WAP4 recorders with integrated locators or Garmin GLO locator. WTopcon Hiper SR GNSS locators are used to store the positioning data (precise point positioning p. 16)

Measuring can be started on any plot of a cluster. **The center point should always be postioned with the GNSS device in the field if it is possible that the sample point falls into forestry land or that the 9m fixed-radius plot includes productive forest land, poorly productive forest land or unproductive forestry land.** If it can be clearly observed in the field that that the sample plot does not include forestry land, the land use class can be determined just using the map data. Otherwise, "measuring from the map" can be used only in exceptional cases to avoid remarkable amount of additional work to access the plot.

A handheld locator or other measurement is used to navigate the plot and place it in the field. It is essential for the placement of the plot that the team leader does not select the position of the plot in the field, but the position of the center is determined objectively, and that the location of the plot is known with the accuracy required for the purpose of the plot. Accurate positioning data must be collected with a Hiper SR locator if the 9 m radius plot is located even partially in productive or poorly productive forest land. For other plots the positioning data collected by less accurate handheld locator is sufficient. Information on how the location of center point is determined is stored in the 'Center position' variable (p. 15). The 'Precise point positioning' variable (p. 16) stores information on whether and how positioning data from the plot is stored on the Hiper SR device.

If the GNSS receiver does not work on the site, the sample points are located along the cluster line using measuring tape and compass. If the location data with the Hiper SR equipment cannot be collected from the plot, it will be collected later, if necessary.

The permanent sample plots are located using the GNSS, plot description sheet and plot's tree map. The plot description sheet describes the plot, its immediate surroundings and the fixed points. The tree map shows the locations of the trees measured in the previous inventory. The plot tree map shows also some variables observed at the previous measurement. Even if there were no trees recorded in the previous assessment, the plot map is printed to show this additional stand information (in cases where the sample point is located on forest land, poorly productive land or unproductive land). For the re-measurement of dead trees, information on dead trees from the previous measurement is listed in the P-permanent tree map.

Locating sample points with GNSS

The team can use either the GNSS receiver or map and compass to approach the sample point. Navigation is started by switching on the locator and starting the navigation program (Vgps). First, the cluster ID and plot number are entered into the application. Then the program calculates and shows the distance and direction to the sample point from the current location. The program displays the direction that can be used with 360-split hand compass and it automatically adds the correction for declination. If map and compass are used for approaching the sample point, the GNSS navigation is started at the vicinity of the sample point.

New plots: temporary plots (K) and permanent plots to be established (X) or re-established (P and U)

When, according to the locator, the center of the plot is less than 10 meters away, a plot locating point is defined. From this locating point, the location of the center of the plot in the field is determined. The aim is to place the locating point in an open place so that the canopies of trees and other obstacles doesn't limit the reception of satellite signals.

After walking and accessing to the locating point, it is often necessary to stop and wait, since the coordinates does not always stabilize immediately. Usually the movement stabilizes in 10 seconds. At the same time, the number of satellites is monitored. If the coordinates do not stabilize, or if less than five satellites are visible, a new locating point will be selected to acquire more satellites and/or better signal. If a satisfactory locating point is not found after some trials, the best previously tested locating point can be selected.

Once the location point is selected, the locating of the center point is started using the Vgps program. If there are less than 5 satellites' signals available, the program asks if you really want to start the averaging the GNSS recordings. After averaging for 20 seconds, the program displays the distance and bearing to the actual sample point. In order to ensure that the team cannot "predict" the location of the sample point, the program selects a randomly a 10 seconds interval for calculating the final coordinates for the sample point. The distance and bearing to the sample point are stored into an input data file. If you find at this stage that the actual sample point is closer than 5 meters from the locating point, it is not necessary to select another locating point.

After receiving the distance and bearing to the sample point, the team leader stays on hold and tells the assistant the distance and bearing. Next, the distance to the sample point is measured using a measuring tape and team leader must follow that the tape is pointing to the correct direction. At the same time, the coordinate recording continues for another 5 seconds.

The averaging function of the Vgps program recalculates the location of the sample point and shows the result. If the new location deviates more than 10 meters from the earlier defined coordinates, the Vgps program displays the difference and asks to repeat the locating procedure (including selection of the locating point, averaging and measuring the distance and bearing to the sample point). This relocating is repeated two times the maximum. If after three trials the difference is still more than 10 meters, the latest locating point is accepted.

If the calculated coordinates deviate more than 30 meters from the location printed on the map, the locating procedure must be repeated, but not more than twice. After the third trial the latest location point is accepted. Nevertheless, if the difference to the map coordinates is more than 50 meters, calculated coordinates are rejected and measuring with a measuring tape and compass from the closest fixed (reference) point is used, instead. The fixed point, distance and bearing from the fixed point to the sample point are written down on the cluster description sheet.

When it is already seen in the navigation phase that the plot is located entirely on non-forestry land, the center point can be determined with a locating device without the procedure described above. The center position code is then 7 (p. 15).

Permanent sample plots to be remeasured (P- ja U-permanent plots)

Primarily, the old sample point (i.e. plot center point) is located with the aid of GPS coordinates, fixed points and tally tree data. If there was any deviation from true location in the previous measurement, this deviation is already taken into account in the plot coordinates given by the Vgps program. If the plot center point is found, GPS measurement is conducted at the sample point. However, if the GPS coordinates cannot be captured at the sample point (due to trees or other obstacles), it is possible to use any other locating point. In the latter case, the distance and bearing from the sample point to the locating point are recorded.

If it is impossible to find the sample point, the sample point is established at the location recorded with the help of the GPS.
NOTE: If it is 100% sure that the sample point was on agriculture land in the previous assessment and there has not been land use change, but the GPS location leadsto establish the plot into forestry land, then the sample plot is moved to the field (by selecting the most obvious location).

There are separate instructions for the satellite positioning devices and software used (Vgps and Magnet field).

Locating of the sample points along the cluster line

If the GNSS positioning is not successful, sample plots are located using map line survey techniques, by measuring distances along the cluster axis in the field. The measuring directions can vary (forwards/backwards). However, the measuring directions cannot be changed in such way that end parts two measured lines would touch, unless there is a part of line in between which has been measured on the map.

First, a fixed point close to the cluster line is selected. This fixed point should be visible on the map, boundary marks of holdings, or crossings of roads or ditches are often good objects. The selected fixed points are marked with a circle on the map. There might be differences in compass measurements between the team members or due to local variation in declination, so the declination should be regularly follow and control the

difference in directions defined between two visible points (along well visible straight line, as road, power line etc.), by comparing directions got from the map and compass. The line is measured horizontally and possible errors due to slope are eliminated by measuring the distance in horizontal segments.

Main working principles on the plots

A sample plot is established in the following cases:
- sample plot falls on productive forest land, poorly productive land, or unproductive land; or
- fixed radius sample plot (radius of 9 m) includes parts of productive forest land, poorly productive land or unproductive land.

Temporary and new permanent plots (K-, U- and X-plots) plots established on productive forest land, poorly productive land or unproductive land, are marked with 25 cm long wooden sticks, and the plot number is written on the stick. Plastic sticks are used on old permanent plots (P-plots). If the stick cannot be placed at the true location due to obstacles (e.g. rock, stump, etc.) the stick is located at the closest suitable point towards the principal compass point (N/E/S/W) from the true location. The distance and bearing from the true location to the stick is recorded at the Notations column of the Stand Description sheet. Furthermore, a small stick or paint marking on the top of stone is left for showing the true location of the plot. On the U-permanent plots, the previously recorded transfer information can be found in the tree map. No fixed points neither plot description sheets are used on U- or X-plots.

Fixed reference points have been selected when establishing a P-permanent plot. The sample point description sheet includes input data fields for the fixed points' data (description of the object, sketch map, distance and bearing). Also other information that helps in relocating the sample point are collected (e.g. information about the nearest roads, tracks, ditches, borders). The fixed reference points are usually marked with paint. If suitable objects are not available as fixed points, then a wooden pole (being approximately 1 m long, made from conifer species) will be located 20 meters far from the sample point.

On the remeasured permanent plots, the sample point description sheet must be updated accordingly. The old fixed reference points can be reused, but it is necessary to mark the points again with the paint. New fixed points are established as necessary. A new plastic stick is left on the sample point if the old one has got broken or disappeared.

The team avoid leavibgssigns of their visit on the sample plot. Pruning of branches or clearinging of small trees or bushes should be avoided. Plots located near houses should be treated with specific care and to avoid any signs of measurements. On sample plots located outside forestry land, no markings are done and no plot center point sticks is left.

The measured tally tree and dead tree (on P-plots) data of the previous assessment are stored in the field computer. Tree level variables related to increment are not collected on permanent plots (i.e. thickness of bark, boring of increment or age sample).

Data entry

Data are entered in field computers. The following data are stored: stand description, tally tree and sample tree data. Dead tree data are stored on P-permanent plots. Additionally, seedling description data are recorded in young stands. Data collection is guided and controlled by the data entry application. There is a separate instruction on the use of the data entry application and Soner calliber.

2 GENERAL PLOT DATA

General plot data are collected for identifying the sample plot. These data are always recorded when the team arrives at a new sample plot.

Sampling stratum

Finland have been divided into four sampling strata each having a different sampling design (i.e. shape of the clusters, plot distances, plot numbering). The sampling strata are: 1) Central Finland, 2) Southern Finland, 3) Southern North Finland (excl. Kuusamo) and 4) Southern Lapland. The strata are presented on a map in Appendix 2.

Team leader

Team leader names and codes are given in Appendix 2.

Cluster indeces

The cluster's North and South indeces are printed on the maps. On the permanent clusters '500' has been added into the North index.

Date

The measuring date is stored using the built-in calendar of the field computer.

Inventory region

Inventory regionss are working units given for the teams. Locations and numbers are presented on maps in Appendix 3.

3 STAND DESCRIPTIONS

Work on the sample plot begins by defining the land use polygon(s) or forest stand(s), where the sample point and parts of a sample plot are located. A forest stand is forest area that is homogenous in respect to administrative data, forest use restrictions, site factors, characteristics of growing stock, accomplished and recommended measures. The stand level variables describe the nearest 0.25 hectares to the plot center.. If necessary, even smaller stands can be described when they clearly belong to different land use class or they are otherwise clearly distinct. Defining continuous cover forest stands is described in Chapter 3.3.

A tally tree plot is a circle with a maximum radius of 9 m. The plot may be divided into several stands. The stand where the sample point is located is referred as sample point stand; other stands containing part of the plot are secondary (plot) stands.

The stand description should describe the nearest quarter hectare of the stand, not only the part where the plot is located. However, some soil variables are an exception of this principle (as described later in details).

All the stand variables (according to the land use class) are recorded for the sample point stand, even if there are no trees in the plot. For the secondary plot stands, the stand variables are recorded only if there is at least one tallytree is measured in the stand. If there are no trees recorded in a secondary plot stand, only type of measurement and shortened stand description is needed (land use class, FRA-class and changes in these, main type, site class, development class, dominant tree species, drainage and performed forest management).
On the permanent plots the same principles are followed: if there is tally tree measured in a secondary plot stand, only the 'shortened stand description' is needed (even if there is a stump of a tally tree measured in the previous NFI, or a non-usable dead tree measured as a living tree or usable dead tree in the previous NFI).

Plot number

The plot numbers are presented in Figure 1. In South Finland the plots 3-12 are measured on P-permanent clusters and plots 1–9 are on K-, U- and X-clusters; in Central Finland plots 2–1o are measured on all clusters. In Southern North Finland (Kainuu, North Osthrobothnia, excl. Kuusamo) plots 1–4 and 6-9 are measured on K-, U- and X-clusters and plots 3–13 on the P-permanent clusters. In Southern Lapland and Kuusamo plots 1-10 are measured on K-, U- and X-clusters and 3–13 on the permanent clusters.

If there are several adjacent plots outside forestry land (e.g. field, water) on the cluster containing exactly similar stand description information, then these plots can be described within a single stand description record.

Location method (plot center point)

The method of locating the sample point is recorded for each sample point stand. If the sample point was located using map, the code is '0'.

On P- and U-permanent plots the Location method variable describes if the original sample point was found (codes 3 and 4) or if it was necessary to re-establish the sample plot (codes 1–2 and 5–6). On the permanent plots the codes 1, 2, 5 and 6 are used to describe the history of (old) tally trees. This information is used in estimating the cutting removal.

Codes 1 and 2 are used on the permanent plots if the sample plot needs to be re-established and if there was no trees in NFI12, or there are no more trees to be measured (if all the previously measured trees have obviously been removed in a regeneration cutting). In the latter case, the old trees are recorded as stumps even if the stumps cannot be found. Codes 5 and 6 are used if there were some trees measured in the previous assessment and this time it is not possible to find out if these same trees. In this case the old tally trees are recorded as "lost".

The codes are as follows:

0 Sample point located with the help of a map.
1 Sample point located with a GNNS measurement. Old tally trees do not exist, or all old tally trees have obviously been removed in a regeneration cutting.
2 Sample point located using measuring tape and compass. Old tally trees do not exist, or all old tally trees have obviously been removed in a regeneration cutting.
3 Permanent plot; sample point is found.
4 Permanent plot; sample point relocated using old tally trees and/or fixed (reference) points.
5 As code 1, but there is no certainty about the status of old tally trees.
6 As code 2, but there is no certainty about the status of old tally trees.
7 Plot center point is measured using a handheld GPS (without averaging function).
8 Poorly productive or unproductive land. Based on a prior interpretation of an aerial image, the sample plot has not been established for time saving reasons. Stand descriptions is done remotely.

GNSS positioning center point

GNSS positioning of the center point (with the Hiper SR device) is performed on plots that require accurate location information. These are the plots where the 9.00 m radius circle is, even partially, in forest or poorly productive forest land. Location data is normally collected for the time taken to measure the plot, but at least 20 or 5 min / plot, depending on the plot.

The GNSS device is placed as close as possible to the plot center point, but in such a way that it does not interfere with the Sonar repeater at the center of the plot. The antenna of the GNSS device and the Sonar repeater are placed on a common stand made for them so that the repeater is exactly above the center point and the antenna is 30 to 80 cm from the center. If there are no measurable trees in the plot, precise positioning can be done from the center point. If the precise locator does not get a good connection to the satellites from the selected precise positioning point, it can be done even further.
GNSS positioning can also be done from a distance in cases where the GNSS antenna cannot be located in the immediate vicinity of the plot (e.g. plot on a road or in a cultivated field). If GNSS positioning has been performed, the direction and distance from the positioning point to the center point of the plot shall be recorded.

The codes are as following:

0 No GNSS positioning needed. The plot is entirely some other land use class than productive forest or poorly productive forest land.
1 GNSS positioning did not succeed.
3 GNSS positiong performed. Location data collected for at least 20 min.
5 Short GNSSpositioning performed. Location data collected for less than 20 min, but for more than 5 min. Plot is divideded and secondary stand is productive forest or poorly productive forest land, or development class is clear cut area or young seedling stand.

Short positionings should be avoided. Significant obstacles to satellite visibility (dense forest, large trees, cliffs, etc.), especially in the southeast-south-southwest direction, require a full 20 min. positioning.

Distance from the positioning point to the plot center point (cm)

Distance from the positioning point to the center point of the plot. Recorded if GNSSpositioning data have been collected on the plot (GNSS positioning code is 3 or 5). The distance is 0 if the positioning is on the plot center point.

Bearing from the GNSS positioning point to the center point of the plot (degree)

Bearingfrom the GNSS positioning point to the center point of the plot with a 360-degree hand compass. Recorded if GNSS positioning data has been collected from the plot (GNSS positioning code is 3 or 5). The bearing is 0 if the positioning is done above the center of the plot.

Number of described stand

The stands are numbered sequentially starting from one. The center point stand always gets the number 1, the numbering order of the secondary stands is free.

Stand proportion

Table 1 is used to help determine the proportions of the stand in the plot circle.

The estimated proportion on the 9.00 m fixed-radius plot

The estimated proportion of the stand in tenths on a 9 m fixed-radius plot. If the plot is located entirely in a single stand, the proportion is 10. The sum of the estimated plot proportions over all stands shall be 10.

The estimated proportion on the 4.00 m fixed-radius plot

The estimated proportion of the stand in tenths on a 4 m fixed-radius plot. If the plot is located entirely in a single stand, the proportion is 10. The sum of the estimated plot portions over all stands shall be 10.

The estimated proportion of a center point stand on the 7 m fixed-radius plot (P-perm.plot./cent.p.)

The estimated proportion of a center point stand in tenths on the 7 m fixed-radius plot (only P-plots)

Table 1. The estimated proportion of a stand

Proportion of center point stand	Proportion of side stand	Radius of the plot		
		9,00 m	7,00 m	4,00 m
		Distance to stand border, m		
5	**5**	< 0,7	< 0,6	< 0,3
6	**4**	0,7 - 2,1	0,6 - 1,7	0,3 – 0,95
7	**3**	2,1 - 3,6	1,7 - 2,8	0,95 – 1,6
8	**2**	3,6 - 5,3	2,8 - 4,1	1,6 - 2,3
9	**1**	5,3 - 7,2	4,1 - 5,6	2,3 – 3,2
10	**0**	> 7,2	> 5,6	> 3,2

Reference points for stand identification perm.pl. / cent.p.

The additional reference points for the stand identification are the points located at a distance of 7.50 m (measured by steps) from the center point in the cardinal directions. Forthese reference points it is recorded to which stand the point falls. The information specifies the weighting of secondary stands. Recorded on all permanent (P, U, and X) plots.

If the proportion of the center point stand is 10 on the 9 m fixed-radius plot, the field computer proposes code 0 for the reference point in the North indicating that all four reference points are on center point stand.

Reference point in theNorth

E Not recorded, if plot is not established (9.00m plot does not include productive forest, poorly productive or unproductive forestry land). The field computer no longer asks for other points.
0 All four points in thecenter point stand.
1 Point locating in center point stand
2 Point locating in stand 2
3 Point locating in stand 3
etc.

Reference point in the East / South / West

1 Point locating in the center point stand
2 Point locating in stand 2
3 Point locating in stand 3
etc.

3.1 ADMINISTRATIVE DATA

The administrative data consist of real property register data (municipality, village, estate register codes), ownership category and restrictions for forestry. Part of these data have been gathered in advance and printed on the maps. The existing information is stored also into the field computer and displayed by the data entry program.

Municipality (municipality code)

The municipality codes are printed on the maps. The codes follow the codes of the Statistics Finland. Municipality code must be recorded/checked, no matter what is the land use class of the stand. If the plot is located outside the inventory region (e.g. some plots of a cluster may be another side of the borders of Finland), then municipality code 999 and land use class B are used.

Village

The village codes follow the codes given by the National Land Survey of Finland. Code is given only for stands located on the forestry lands. The code is entered in the office in advance.

Real estate register code

The real estate register code consists of two components: base state (Code 1) and estate register code (Code 2). The code is recorded only for plots on forestry land, and value of 0 is used in other land use classes. If there are no real estate register codes available on the map, the value 0 is used for both the code components.

Estate register code 1

The estate register code 1 is numeral value. Max. 4 digits.

Estate register code 2

The estate register code 2 is numeral value. Max. 4 digits.

Ownership category

The ownership group code is recorded in the field, if the ownership group is printed on the map or if the ownership group can be correctly determined in any other way. Otherwise, code 0 is used and the ownership group will be defined after field work using the official land register information. The codes are as follows:

0 Unknown

Private, non-industrial

1 Private forest owner: private forest land owner, one-man business company, heirs, and reliction land that have no defined ownership but that will be shared among the neighbouring estates.

Ltd companies

2 Forest companies. Includes also companies in the round wood business.
3 Other companies.

Government forests

4 Metsähallitus (Forest and Park Service).
5 Other governmental institute.

Municipalities, communities

6 Commonhold forests
7 Municipalities
8 Church,
9 Other communities

No defined ownership

A No defined ownership

Restrictions on forestry

Some restrictions on forestry activities have been searched and marked on the maps in advance. Restrictions are mainly caused by conservation areas established for conservation of nature and biodiversity. However, some of the conservation areas have no restrictions for forestry (e.g. landscape protection areas, ridge protection areas). Also other land uses may cause restrictions for forestry activities, as military training sites.
. For the forests owned by government the restrictions on forestry will be checked after field work by Metsähallitus.

If the field the team finds out a conservation area (or other special use area) that has not been pre-printed on the map, this area must be drawn and described in the map.
The restriction codes are as follows:

0 **No restrictions**

1 **Areas protected by nature conservation act**
101 Nature park
102 National park
103 Mire/peatland conservation area
104 Herb-rich forest conservation area
105 Other conservation area

106 Nature monuments or archeological remains
107 Biotopes protected by the Nature Conservation Act
108 Conservation area for old growth forests
109 Conservation area for landscape scenery

2 **Other protected areas based on legislation**
201 Wilderness reserves. Divided into strictly protected areas and areas where some operations are allowed.
202 National hiking areas. Based on law.
203 Governmental hiking areas. Based on law.
204 Archaeological remains. Based on law.
205 Other area protected by law.

3 **Protection or restrictions based on owners' decision**
301 Protection areas of Metsähallitus (Forest and Park Service).
302 Special areas under the Landscape Ecological Planning, owned by Metsähallitus.
303 Other restricted areas owned by Metsähallitus (ecological corridor, game reserves etc.)
304 Other conservation or restricted areas, owned by companies, state organizations, municipalities etc.
305 Research forests, gene reserves, trial plantations, etc.
306 Recreation areas, public parks, forests near hiking trails, etc.
307 Forests used as Military training sites
308 Other special-use areas

4 **Forests under preparation of protection**
401 Areas under the programme for expanding nature reserves and national parks
402 Mire protection programme
403 Herb-rich forest protection programme
404 Old-growth forest protection programme
405 Shoreline areas protection programme
406 Waterfowl habitats protection programme
407 Glacifluvial esker formations protection programme
408 Other protection programmes
409 Other areas reserved for protection by the Government decision

5 **Regional plan areas**
501 Regional plan area
502 Master plan
503 Town plna area
504 Detailed shore plan

Some of the regional zoning areas are marked on the maps. The extracted restrictions and their codes are:

A Suburban area
C Area of urban services
R Area of leisure homes
T Industrial area

E Special services area
L Traffic-influenced area
P Area of services and governing
M Agricultural and forested land
V Recreational area
S Protected area
X Protected area 2

Level of restriction

Describes how much the conservation/protection restricts forestry operations.

- No restriction.
0 Conservation or protection does not restrict forestry operations.
1 All forestry operations are forbidden.
2 Actual forestry operations are prohibited but other activities aiming at maintaining the natural characteristics of the forest are allowed.
3 Forestry operations are prohibited but only in some parts of the stand.
4 Forestry operations are allowed if drastic changes can be avoided.

Other special values

Other special value describes existence of restrictions to forestry due to special natural, aesthetical or other values found at the site. This data is recorded only if the restrictions affect at the 9 meter fixed radius plot.

0 No other special values.
1 Biotope protected by the Forestry Act.
2 Forest by shoreline.
3 Forests at immediate vicinity of houses and special attention must be taken in forestry operations.
4 Aesthetical values.
5 Habitat of a rare or vulnerable species.
6 Other reason.

3.2 LAND USE CLASS, SITE AND SOIL DESCRIPTION

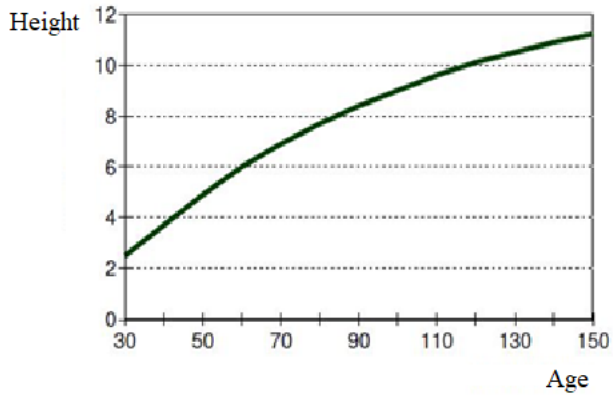
Land use classification

Special attention need to be paid to land use classification. Systematic classification errors must be avoided. Normative minimum width for roads, water basins (rivers) and power lines is 5 meters.

Small patches of forests, inside land use classes 5–8, are included into the surrounding land use classes if they cannot be regarded as forestry land. Small islands, however, are always separated as individual land use units, i.e. small islands are never classified as water. If the sample plot (or part of it) falls outside the inventory region (e.g. beyond the national borders), code B (sea) is recorded for the land use class and code 999 for the number of municipal.

Land use class

1 *Productive forest land* is land used or available for growing trees. The mean annual increment under favorable growing conditions and within recommended rotation period is at least 1 m3/ha including bark, or 0,85 m3/ha excluding bark. Productive forest land includes afforested (planted or seeded) stands that have of other land use classes earlier and the seedlings are capable to develop further, even if the site index would indicate lower production capacity than 1 m3/ha/year.



Forest age (years)	Mean height (m)
30	2,5
40	3,7
50	4,9
60	6,0
70	6,9
80	7,7
90	8,4
100	9,0
110	9,6
120	10,1
130	10,5
140	10,9
150	11,2

Figure 2. The dominant tree height at the limit between productive and poorly productive forest land as a function of stand age.

2 *Poorly productive forest land* is land used or available for tree growing. The mean annual increment is 0.10–0.99 m3/ha/year including bark. Figure 2 can be used for distinguishing poorly productive land and productive forest land.

3 *Unproductive land* is forestry land where potential mean annual increment is less than 0,10 m3/ha/year. Single, poorly growing trees and shrubs may typically occur on unproductive land.

4 *Other forestry land* includes forest roads, seed production stands, permanent depots and build-up land for forestry purposes. This class also includes gravel and sand production sites, game feeding areas etc. within forests.

Forestry land consists of land use classes 1–4. The other classes are as follows:

5 *Agricultural land*, which includes fields, pastures, and unproductive land inside these land use classes, small roads and buildings (other than houses) used for agriculture.

6 *Built-up land* is land used for buildings, houses, and factories and land in the immediate vicinity of these. This class includes peat production areas, where peat harvesting has been started and the site has not reforested. Also mechanized gravel production sites and mining sites are included into this class. It includes also some wooded areas like parks, grave yards and corresponding areas.

7 *Roads*, which include roads and railroads, ditches and open side areas close to these. It includes also airports. Roads inside build-up areas (towns etc.) are classified as built-up land.

8 *Power supply lines* include electricity lines, water tube lines and gas tube lines. The width of the line must be at least 5 meters. If the line is inside other land uses classes than forestry land (1-4), it is included into the surrounding land use class despite of the width.

A *Inland water*. Water courses (rivers etc.) less than 5 meters in width are included into the surrounding land use class.

B *Sea*.

Land use class specification and change

Data on land use classes and changes between land use classes are used, for example, in the greenhouse gas inventory of LULUCF sector. The land use class, land use class specification and FRA category are used to define the six IPCC land use class to be used in the GHG inventory.

For reporting under the UN Framework Convention on Climate Change (UNFCCC), land use classes are divided into those that have remained in the same land use for the last 20 years and those that have changed from other land use to the current category in the last 20 years. For the purposes of reporting under the Kyoto Protocol, afforestation and deforestation after 1989 and changes in carbon stocks are monitored. In the UNFCCC reporting, FRA class 1 forest is forest land without area requirement. In Kyoto reporting, the minimum forest area requirement is 0.5 ha. The same minimum area requirement applies to afforestation and deforestation. The size of the converted area is recorded in order to separate the Kyoto forest from other forest land, and also because the total area of sites smaller than the minimum area must also be reported.

Specification of land use class LUC 1–6,A

The specification of land use class divides the land use class into subclasses. This data is registered for land use classes 1–6 and A.

Productive forest land

0 Normal forest land.
5 Forest pasture. The area is used for grazing, but it is categorized as forestry land. A heavily grazed - usually fenced - area is considered agricultural land.
6 Forested or afforested stand converted from previous soil class 5 – B, as a result of which the habitat of the stand cannot be considered authentic; e.g. afforested field, peat bog or gravel pit.

Poorly productive forest land

0 Normal poorly productive forest land.
5 Forest pasture. The area is used for grazing, but it is categorized as forestry land.
6 Forested or afforested stand converted from previous soil class 5 – B, as a result of which the habitat of the stand cannot be considered authentic; e.g. afforested field, peat bog or gravel pit.

Unproductive land

0 Unproductive land with vegetation cover.
1 No vegetation cover: open rocks, sandy areas etc.

Other forestry land

4 Seed production forest.
6 Forestry buildings or land in immediate vicinity of these.
7 Forest road.

8 Small-scale peat production site.
9 Gravel/Sand production site that belongs to forestry land.
1 Other land in the class forestry land, mineral soil type.
2 Other land in the class forestry land, organic soil type.

Arable land

0 Farmed fields or fallows, includes ditches less than 3 m in width.
1 Abandoned field, mineral soil type.
2 Abandoned field, organic soil type.
3 Abandoned field, reforestion ongoing, mineral soil type.
4 Abandoned field, reforestion ongoing, organic soil type.
5 Pasture, meadow.
A Unproductive land inside arable land. Includes ditches more than 3 m wide and other field edge areas.
B Barns and other buildings for agriculture business (but not houses) and areas in immediate vicinity of these.
C Fruit tree or berry shrub plantation. For example, an apple, sea buckthorn, red/black currant or raspberry plantation.
6 Land for bioenergy production (woody plants, as willows), mineral soil type.
7 as code 6, organic soil type.
8 Land for bioenergy production (non-woody plants), mineral soil type.
9 as code 8, organic soil type.

Build-up land

5 Green house, yard, home garden.
6 Mining area
8 Peat production area, production ongoing.
1 Peat production area on preparation.
2 Peat production area, out of use. Not yet converted to other land use, but vegetated.
3 Peat production maintenance area
4 Surface drainage area on peat production area
9 Gravel/Sand production site that does not belongs to forestry land.
0 Other build-up land.

Inland water

0 Natural water basins. Includes also natural lakes with controlled level of water.
8 Artificial lake, tamed river.

Previous land use class and its specification LUC: 1–A

Previous land use class is used for monitoring the changes between land use (LU) classes and IPCC land use after the beginning of 1990. Thus, these variables describe the latest change in LU. Changes are not recoded when abandoned field starts reforesting (51 -> 53, 52 -> 54) or specification on peat production area changes (between 61, 62, 63, 64, 68).

No change

0 The land use class and the specification has not changed after the beginning of 1990s.

Former land use class

Productive forest land	Poorly productive forest land	Unproductive land	
11	21	31	Previous LU was 1–3, mineral soil type
12	22	32	Previous LU was 1–3, organic soil type
		39	Previous LU was 3, mineral soil type, no vegetation cover

Former other forestry land

44 Seed production forest.
46 Forestry buildings, constructions & related land.
47 Forest road.
49 Gravel/Sand production area.
41 Other land in land use class 4, mineral soil type.
42 Other land in land use class 4, organic soil type.

Former arable land

50 Actively farmed field, includes ditches less than 3 m wide.
51 Abandoned field, mineral soil type.
52 Abandoned field, organic soil type.
55 Pasture, meadow.
5A Unproductive land inside arable land. Includes ditches more than 3 m wide
5B Field road. Barns and other buildings for agriculture business (but not houses) and areas in immediate vicinity of these.
5C Fruit tree or berry shrub plantation.

Former built-up land

65 Greenhouse, yard, home garden.
66 Mining area.
68 Peat production area.
69 Gravel/Sand production area.
60 Other build-up land.

Former roads

70 Roads.

Former power lines

80 Power lines.

Former inland water

A0 Natural inland water.

A8 Artificial lake, tamed river.

Former sea

B0 Sea.

Timing of the land use change

The timing of the change is registered with the accuracy of one year. The changes that occurred about 1990 must be estimated with specific attention. It is important to separate changes that occurred before and after the year 1990. Latest change is recorded even when it it recorded on previous inventory.

-	No changes after the beginning 1990.
20	Change occurred in 2020
19	Change occurred in 2019
18	Change occurred in 2018
…	
92	Change occurred in 1992
91	Change occurred in 1991
90	Change occurred in 1990.

Area of change

0	Area of change is less than 0.5 ha.
1	Area of change is greater than or equal to 0.5 ha.

Verification of the previous land use class

Because the estimation of the previous land use class is sometimes uncertain in the field, so some changes need to be checked using ancillary information sources. This variable intents to give information about the uncertainty of this assessment. The codes are as follows:

0 The estimation of land use class is relatively certain (in relation to 1990).

1 The estimation of land use class is relatively certain (in relation to 1990), but it should be checked from other information sources whether the land use class has changed before or after 1.1.1990.

2 The timing of the change is relatively certain, but the specification code could not be verified.

3 The timing of the change is relatively certain, but the whole change code could not be verified.

4 Both the change code and timing are uncertain.

Type of measurements

The *type of measurement* informs that which data records have been filled for the stand. This information is used to correctly identify the records in the data processing. This variable also guides the data entry program.

0 No tally trees were measured in the stand.

1 Tally trees were measured in the stand.

7 Tree records have been entered in the previous NFI (on a permanent sample plot), but these trees do not exist anymore, or cannot be accessed. Used tree type codes are K, R, M, J, E, P, Z, X or A.

8 Plot which belongs to land use classes 1 or 2, but it has not established. Plot not visited, probably no tally trees exist in the plot.

9 Plot belongs to land use classes 1 or 2, not established. Plot not visited, probably there would be tally trees in the plot.

FRA land use class, and its change

FRA land use class codes are used in the reporting for the FAO Global Forest Resource Assessment. The change data are used in Green House Gas reporting.

FRA land use class LUC: 1–8

According to the FRA guidelines, the land is divided into *forest* and *other wooded land* according to the tree height and crown coverage. Land filling neither into the *forest* nor the *other wooded land* classes is classified as *other land*.

FRA land use class is registered for all plot stands and for those secondary (plot) stands which got tally trees.

The FRA land use class is defined as follows:

- In a plot stand: FRA class at the plot center point.
- In a secondary plot stand: FRA code of the stand.

The stand delineation is done independently for the national definitions and FRA definitions. Note that FRA stands must fulfill the minimum size and width criteria according to the FAO definitions.

In unmanaged and non-drained stands (of poorly productive forest land or unproductive land) the FRA classes can usually be estimated according to the current growing stock. If there has been any cutting, the removed trees must be considered in the classification. In drained (ditched) stands the development of crown cover is estimated assuming that the ditches will be kept maintained in the future. However, if the drained stand is classified with the codes D–F (=”maintaining of ditches not feasible”), maintenance of ditches is not assumed.

1 *Forest.* At the maturity stage the crown cover exceeds 10 %. Trees are able to reach at least the height of 5 meters. The size of the forest must be at least 0.5 hectares and the width at least 20 m.

2 *Other wooded land.* At maturity stage the height of trees is at least 5 meters and crown cover 5–10 % **or** the crown cover of trees and shrubs exceeds 10 %. Shrubs are usually more than 0.5 m and less than 5 m tall multi-perennial, usually multi-stemmed woody plants. *Other wooded land* must exceed 0.5 hectares in size and 20 meters in width.

3 *Other land.* Land does not fall into Classes 1, 2, or 4. No minimum criteria for the area.

4 *Other land with tree cover*. In the FRA system this is a sub-class of class 3, filling the minimum criteria for growing stock and stand size, e.g. parks, wooded yards, wooded pastures. If the area is bordered by a (FRA) forest, it may be taken into account when assessing the area and width requirement (clarified in 2019).

Previous FRA land use class

0 No change
11 FRA class was earlier 1, mineral soil type.
12 FRA class was earlier 1, organic soil type.
21 FRA class was earlier 2, mineral soil type.
22 FRA class was earlier 2, organic soil type.
30 FRA class was earlier 3, mineral soil type, no vegetation.
31 FRA class was earlier 3, mineral soil type, soil class 3, with vegetation.
32 FRA class was earlier 3, organic soil type.
41 FRA class was earlier 4, mineral soil type.
42 FRA class was earlier 4, organic soil type.
Previously inland water:
A0 Natural water body.
A8 Artificial lake, tamed river.
Previously sea:
B0 Sea.

Time of change - FRA land use class

The timing of the change is registered with the accuracy of one year. The changes that occurred about 1990 must be estimated with specific attention. It is important to separate changes that occurred before and after the year 1990. Latest change is recorded even when it wasrecorded in theprevious inventory.

0 No change after 1.1.1990.
20 Change after 2020.
19 Change after 2019.
18 Change after 2018.
..
92 Change after 1992.
91 Change after 1991.
90 Change after 1990.

Area of change – FRA land use class

0 Area of change is less than 0.5 ha.
1 Area of change is greater than or equal to 0.5 ha.

Verification of the previous FRA land use class

0 The estimation of the FRA land use class is relatively certain (in relation to 1990).
1 The estimation of the FRA land use class is relatively certain (in relation to 1990), but it should be checked from other information sources whether the land use class has changed before or after 1.1.1990.
2 The timing of the change is relatively certain, but the specification code could not be verified.

3 The timing of the change is relatively certain, but the whole change code could not be verified.

4 Both the change code and timing are uncertain.

Comparison of the change recordings (on permanent plots)

0 The previous land use class, previous FRA class, and timing of changes are in accordance with the recordings conducted during the previous assessment.

1 The previous land use class, previous FRA class, or timing of changes are not in accordance with the recordings conducted during the previous assessment. There has been done a change coding either in land use class or FRA coding.

2 There is a conflict between land use class and FRA codes, although there have been no changes.

Nearest stand border **LUC: 1–3/ center point/ r=30**

Description of the nearest stand border is needed for satellite image interpretation. These data are recorded on *productive forest land, poorly productive land* and *unproductive land*. The nearest stand border within the radius of 30 m from the plot center is described. A stand border can be a border between land use classes, peat land and mineral soil, or two stands with different development classes or species compositions. If there are more than one stand borders about within the same distance, the most visible border is recognized. A border between two real estates is not regarded as a stand border.

On satellite images, the most visible borders are usually borders between wooded and non-wooded land use classes. Within the productive forest land, the most visible borders are borders between some development classes and the changes in the share of deciduous/coniferous tree species. Changes in the mean timber volume are more visible in young stands than in the older stands.

The distance and bearing to the stand border is recorded as follows:

Bearing to the nearest stand border

0 No stand border within 20 m from the plot center.
1 Stand border in Northeast
2 Stand border in East
…
8 Stand border in North

Distance to the nearest stand border (m)

Distance to the nearest stand border with an accuracy of 1 meter.

Fixed reference point for a stand **LUC: 1-4**

When the plot center is less than 3 m from the border between two real estates, a fixed point for each stand on the plot must be defined. Reference point is always recorded for secondary stand on the plot. A fixed point is selected so that it is at least 5 m from the stand border.

Distance to fixed reference point from the plot center (m)

Distance to the fixed reference point recorded with an accuracy of 1 meter. 0, if fixed point is not needed.

Bearing to fixed reference point from the plot center (degree)

Bearing to fixed reference point from the plot center with degrees.

Type of the organic layer LUC: 1–3/ r=9,00

Type and thickness of the organic soil layer are defined for stands on *productive forest land, poorly productive land* and *unproductive land*. The values are observed inside of the tree tally plot (radius of 9 m) at 4 objectively selected points (the corner points in Figure 3). Note: mould (soil) is regarded as organic soil.

0 Organic soil is as very thin layer (<1 cm) or missing.
1 *Raw humus*. Formed from dead plants previously growing on mineral soils, feels like felt, layer is clearly distinctive from the mineral soil.
2 *Humus.* Typically a thin layer, lower part mixed with mineral soil, but in the upper part there is a clear decomposed dead plant layer under the litter fall.
3 *Mould*. Organic layer fully mixed with mineral soil, between the litter fall and mineral soil. Occurs on the richest soil types and abandoned agricultural land.
4 *Peat.* Formed from peat land vegetation, mostly of mosses. Composition stage varies in different layers. If there is a layer of raw humus above the peat layer and the peat layer is more than 50 % of the total thickness of the organic layer, the organic layer is regarded as *peat*; otherwise it is regarded as *raw humus*.
5 *Raw humus above peat layer.* The organic layer is mostly of peat (class 4) but above the peat layer there is more than 4 cm layer of raw humus.
6 *Peat-mull.* Non-layered, evenly composed peat, usually as thin layer, occurs mainly on thin ditched peat lands, abandoned agricultural land and pastures.

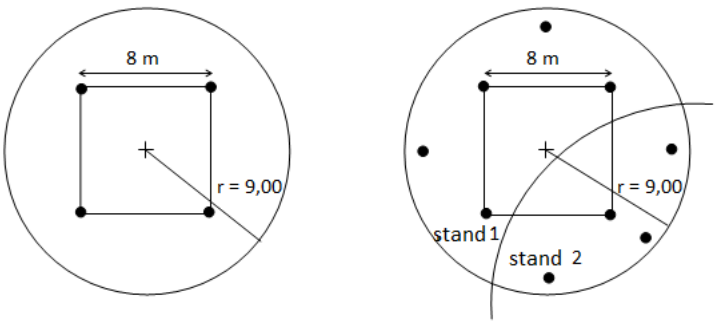


Figure 3. Observation points for soil type and organic layer data.

Thickness of the organic layer **LUC: 1–3/ r=12,xx**

The thickness of the organic layer is defined at the same points as the organic layer type. This data is measured with 1 cm accuracy but if the thickness is more than 30 cm, 5 cm classes may be used in recording. The thickness of the organic layer is measured downto the depth of 2 m. If the soil is frozen and cannot be measured, then code E is used.

Soil type **LUC: 1–3/ r=9**

Soil type is observed at the depth of 10–30 cm, at 2–4 observation points (Figure 3) depending on the variation of the soil. Soil type is recorded on *forest land*, *poorly productive land* and *unproductive land* inside of the tree tally plot (radius of 9 m).

Soil type is *rock* type or *stones* type if the soil layer (organic + mineral soils) is less than 10 cm. If the organic layer above the mineral soil is less than 30 cm thick or if the soil depth is 10–30 cm and there is mineral soil between the organic layer and the base rock, the soil type is defined solely according to the mineral soil layer.

0 *Organic*. Organic layer is at least 30 cm, or the layer (more than 10 cm) above base rock is organic.
1 *Rock*. Thickness of the organic layer and mineral soil layer together is less than 10 cm.
2 *Stones.* Uniform layer above the base rock, formed by stones (2–20 cm) and large stones or boulders (>20 cm). There is no soil between the stones, but soil may occur below the stone layer.
3 *Glacial till*. Non-sorted or slightly sorted mineral soil. Stones are sharp and there is a mixture of almost every particle sizes. In the coarsest till the finest particles are missing.
4 *Sorted*. Clearly sorted mineral soil. Soil consists of 2–3 particle sizes. The finest soils (clay, silt) do not contain the more coarse particles, the most coarse soils (gravel, coarse sand) do not contain the finest particles, and the medium coarse soils (coarse silt, fine sand) do not contain neither the finest nor roughest particles.

Mean grain size **LUC: 1–3/ r=9**

The mean grain size is defined, if the soil type is *glacial till* or *sorted*.

0 Soil type is organic, rock or stones.
1 *Fine*. Clay or silt. Most of the particles are not visible. In the fingers it is possible to feel the most groove particles. If the soil is moist, you can bake a cube or roll a line 1 – 6 mm thin.
2 *Medium coarse*. Coarse sand ("*hieta*") and fine sand. Most forested soils belong into this class. Most soil particles are visible with bare eyes. It is not possible to bake in hands a line, but a weak cube may be possible.

3 *Groove.* Groove sand and gravel. The finest particles have flushed away, even if the soil type is *glacial till*. It may be difficult to get the soil sample. Usually there are plenty of stones in the soil.
4 *Coarse sand and pebble*. The finest particles have flushed away, even if the soil type is *glacial till*. It may be difficult to get the soil sample. Usually there are plenty of stones in the soil.

Soil thickness — LUC: 1–3/ r=9,00m

The thickness of soil (organic + mineral soil) above the base rock is estimated using soil stick. Soil thickness is recorded for stands on *forest land, poorly productive land* and *unproductive land*. Observations are done inside the tally tree plot (radius of 9,00 m).

1 *Thickness <10 cm*. The base rock is clearly visible or there are rocks on the plot. The soil stick goes less than 10 cm deep into the soil.
2 *Thickness 10-30 cm.* Base rock is visible or it can be observed with the soil stick.
3 *Thickness > 30 cm.* The base rock is not visible and cannot be observed with the 30 cm soil stick.

Site descriptions — LUC 1–3

Main site type

The *main site type* classifies *forest land, poorly productive land* and *unproductive land* further into *mineral soils* and *peat land* main types. The *peat land* main types are ferns, pine mires, and open bogs. The stand is of the peat land main type if the organic layer is of full peat, or more than 75% of the vegetation is peat land type vegetation. Otherwise, the main site type is regarded as *mineral soil*. Annex 5.1 contains further details for the classification.

Ferns and *pine mires* include drained mires that have been open bogs before the ditching.

1 Mineral soils
2 Spruce dominated mire
3 Pine dominated mire
4 Open mire

Site fertility class

The site fertility classes are used for grouping the forest by vegetation zones into uniform classes according to their site fertility and wood production capacity.

The terms *Southern Finland*, *Pohjanmaa-Kainuu* and *Peräpohjola* are used for forest and transformed mire types to refer to the forest vegetation zones presented in the publication of *Jaakko Lehto & Matti Leikola* ("*Käytännön metsätyypit")* and in Hotanen et al. ("*Metsätyypit – opas kasvupaikkojen luokitteluun")*. Site fertility classes are described in more detail in the appendix 6. The site fertility classes are as follows:

1 *Herb rich sites* (mineral soils, transforming mires) eutrophic mires and fens and corresponding drained mires.
2 *Herb rich heath forests*, (grove-like heath) mesotrophic mires and fens and corresponding drained mires.
3 *Mesic forests* (fresh heath) in mineral soils and meso-oligotrophic natural and corresponding drained mires.
4 *Sub-xeric mineral soil forests* (rather dry heaths) and oligotrophic natural and corresponding drained mires.
5 *Xeric mineral soil forests* (dry forest) and oligo-ombrotrophic natural and corresponding drained mires.
6 *Barren mineral soil forests* and *Sphagnum fuscum* dominated (ombrotrophic) natural and corresponding drained mires.
7 *Rocky and sandy soils and alluvial lands*.
8 *Summit and fjeld forest*.
T *Boreal birch forest*
A *Treeless fjells*

Site fertility class specification code

0 No specification
6 Shallow peat layer; peat layer thickness < 30 cm
7 Mineral soil forest of the Pyrola type. Taxation class IB (not downgraded).

Drainage status **LUC: 1–3**

Drainage status distinguishes natural and drained forestry land compartments and classifies drained mires based on their drainage conditions. Also mires in low productivity forest land and bare land can be classified as transforming mires or transformed mires, but because of poor fertility these sites cannot be classified as forest land.

Generally, hydrological improvement from the forest growth point of view has been the aim of the forest drainage. Drainage for other than forestry purposes (road ditches, agricultural cut-off ditches, individual main ditches etc.) are considered in this context only if the drainage has an effect on trees' growth or the drainage system covers the entire compartment. If ditches in a neighbouring stand have also affected on the plot stand, the plot stand is regarded as 'drained' (even if there are no ditches in that stand).

0 Undrained.

1 Drained mineral soil forest.
2 Drainage effect not yet visible. Drainage has caused no or little effect on mire vegetation and on trees' growth. Also drained sites where the ditches have got blocked (due to natural reasons) and the site has thus regressed back into the conditions prior to the drainage fall into this class.
3 *Transforming mire*. There is a clear drainage effect visible, but the ground vegetation is still characterized by the original mire type. The trees are recovering but in most cases the forest canopy is not yet closed.
4 *Transformed mire* is a drained mire where vegetation resembles one of the mineral forests site types and the hydrology does not limit the closure of the stand's canopy. Restored mires are recorded according to the drainage situation, but due to blocking of the ditches 'paludification, wetness' code can be used on 'taxation class specification' variable.

Mire type **LUC: 1–3, Undrained**

Undrained mires are grouped into mire types according to *Laine & Vasander (2018)*. Annex 7.2 has information to help identification of mire types.

Pure types

1 Eutrophic paludified hardwood-spruce forest
2 Ruohokorpi, RhK
3 Kangaskorpi, KgK
4 Mustikkakorpi, MK
5 Puolukkakorpi, PK
6 Pallosarakorpi, PsK
7 Korpiräme, KR1
8 Pallosararäme, PsR
9 Kangasräme, KgR
10 Isovarpuräme, IR
11 Rahkaräme, RaR

Mixed types
12 Varsinainen lettokorpi, VLK
13 Koivulettokorpi, KoLK
14 Ruohoinen sarakorpi, RhSK
15 Varsinainen sarakorpi, VSK
16 Varsinainen lettoräme, VLR
32 Rahkainen lettoräme RaLR
17 Ruohoinen sararäme, RhSR
18 Varsinainen sararäme, VSR
19 Tupasvillasararäme, TSR
20 Lyhytkorsiräme, LkR
21 Tupasvillaräme, TR
22 Keidasräme, KeR

Open bogs and ferns

23 Varsinainen letto, VL
24 Rimpiletto, RiL
25 Ruohoinen saraneva, RhSN
26 Ruohoinen rimpineva, RhRiN
27 Varsinainen saraneva, VSN
28 Varsinainen rimpineva, VRiN
29 Lyhytkorsikalvakkaneva, LkKaN
30 Lyhytkorsineva, LkN
31 Rahkaneva, RaN

Drained mire forest type **LUC: 1–3, Drainage status: 2–4**

Drained mires (on *productive forest land, poorly productive land* and *unproductive land*) are grouped into *drained mire forest type* classes. The classification is applied also for drained mires that belong to transforming mire or transformed mire types. On drained mire where there is not yet any effect of the drainage to the growing stock, the site is classified according to its original mire type into its corresponding drained mire forest type (see Appendix 7.3).
The drained mire forest types are described in the publication by *Laine & Vasander* ("Suotyypit ja turvakankaat", 2018).

1 Herb-rich type, Rhtkg.
2 Vaccinium myrtillus type (I), developed from genuine forested mire, MtKg(I).
3 Vaccinium myrtillus type (II), developed from treeless more or combination mire type, Mtkg(II).
4 Vaccinium vitis-idaea type (I), developed from genuine forested mire, Ptkg(I).
5 developed from genuine forested mire (II), developed from treeless more or combination mire type, Ptkg(II).
6 Dwarf shrub type, Vatkg.
7 Cladonia type, Jätk.

Latest drainage operation **LUC: 1–3**

The latest drainage operation is recorded with the following codes (on *forest land, poorly productive land* and *unproductive land*):

0 No drainage.
1 New (initial) drainage conducted on undrained site.
2 Clearing of ditches. Clearing of the existing ditches.
3 Supplementary drainage. Supplementing the old ditch network, possibly including clearing of old ditches. This class includes also complete redraining

already on previously drained mires and abandoned agricultural fields on peatland.

4 Drainage exists, but not for forestry purposes (road ditches, agricultural ditches etc.).

5 Blocking of the ditches with the aim to restore the drained mire back to its natural state.

Time of the last drainage operation

The date is recorded a calendar year, up to 50 years back.

– No drainage operations
0 Drainage at the year of the inventory
1 Drainage 1 year ago
2 Drainage 2 years ago
3 Drainage 3 years ago
4 Drainage 4 years ago
…
49 Drainage 49 year ago
50 Drainage 50, or longer time ago.

Need for drainage LUC 1-3

The need for drainage describes the future need of drainage operations from the silvicultural point of view and suitability of the site for timber production. The need is determined for the time period of the next 10 years. The signs indicating the drainage need should be clearly visible; these are as weak condition of ditches, degeneration of trees' growth. Need for drainage does not depend on other forest management recommendations made for the growing stock. Undrained site cannot get a recommendation for drainage operation.

Suitability of mire for timber production and ditch clearing or supplementary drainage is defined by site fertility, heat sum and growing stock. Supplementary drainage is not recommended on poorly productive or unproductive forest land, on 'jäkäläturvekangas' or if the heat sum is belove 750 d.d. Supplementary drainage and ditch clearing can be recommended if

- sufficient amount of suitable trees after first drainage (see table 2)
- most of the trees meet quality requirements of log trees
- growth is at a minimum of 1,5 m3/ha/year even without potassium fertilization

Table 2. Minimum criteria for ditch clearing and supplementary drainage.

	Effective temperature sum. d.d.			
Drainaged mire type	**South Finl.** Over 1200	**Central Finl.** 1000–1200	**South.Nor. Finl.** 900–1000	**Northern Finl.** 750–900
	Minimum number of trees meeting quality requirements, trees/ha			
Rhtkg, Mtkg I	ok	ok	ok	ok

Mtkg II	ok	ok	> 600	> 1000
Ptkg II	ok	ok	> 600	> 1000
Ptkg I	> 600	> 1000	> 1100	> 1200
Vatkg	> 600	> 1100	> 1200	Not ok

Need for drainage

0 *No need for drainage*. No drainage needed or the stand is on undrained mire. If the stand is drained, the drainage system works successfully and there is no need for complementary draining or clearing the ditches.

1 *New draining*. New draining on wet mineral soils.

2 *Clearing of ditches.* Clearing of ditches, either forestry ditches or ditches on forested agricultural land.

3 *Complementary ditching*. Complementing the old ditch network and possibly including the clearing of the old ditches in a forest drainage area.

Codes (D-F) can be used for small-sized drainage sites that were mistakenly drained within a part of larger (successfully) drained mire.

4, D Drained mire is too poor for timber production and maintenance of ditches is not feasible. The drainage system is either in poor condition or too sparse.

5, E Drained mire is too poor for timber production and maintenance of ditches is not feasible. The ditches are in good condition and drainage system functioning.

6, F Drainage area is technically not suitable for drainage (e.g. too flat or low area and water is not moving).

7 Peatland that has been drained for other use than forestry, e.g. for agriculture. The site is too poor for growing timber.

Condition of the ditches **LUC: 1–3/ Perm.plots/ Drained**

Condition of the ditches is assessed together with the ditch spacing measurements, that in drained stands (drainage status 1-4, in *forest land, low productivity forest land* and *unproductive land*) and in permanent sample plots only.

- Undrained.

1 Good. Ditches are as good as new ones and have not become shallower.

2 Satisfactory. Some vegetation in the ditches restricting the water flow, ditches have become a little shallower.

3 Fair. A lot of vegetation in the ditches restricts the water flow, ditches have become shallower.

4 Poor. Ditches have become almost completely blocked.

Taxation class information **LUC: 1**

Taxation of forest owners is no longer based on site productivity classes, as it used to be earlier in Finland. Taxation class is, however, still used in some forest simulations models as a predicting variable. Therefore, the taxation class data are still collected in NFI.

Taxation class

0 IA Herb rich sites and herb rich heath sites in mineral soils (excl. *Pyrola* type sites)
1 IB Mesic forests and herb rich sites of *Pyrola* type in mineral soils
2 II Sub-xeric forests and mesic forests with a very thick raw humus layer
3 III Xeric and barren mineral soil forest, forests with a very thick raw humus and *Pleurozium schreberi* moss layer, natural spruce mires (productivity ≥ 1 m3 ha-1 a-1)
4 IV Natural pine fens and bogs.

Forest land with clearly lower productivity than the normal productivity of that site fertility class is classified according to the actual wood production capacity. Examples of sites of lowered productivity as follows:

- forests on solid rocks or on exceptionally stony soils,
- forests on coast susceptible to wind,
- forests on high altitudes where there are frequent snow damages,
- paludified forests, forests on excessively wet soils, intensively burned forests.

If the productivity of the stand is lower than that of the taxation class IV, the stand is classified as *poorly productivity forest land* or *unproductive land*. In NFI the taxation class is determined based on the current state of the site. When classifying mires, the following assumptions are valid:

- Drained transformed mires are classified in the same way as the corresponding mineral soil forests. Spruce dominated mires of site fertility class 3 normally develop to *Vaccinium myrtillus* peatland forests and are classified in the taxation class IB, if no downgrading factors are present; pine dominated mires of site fertility class 3 normally develop to *Vaccinium vitis-idaea* peatland forests and are classified in the taxation class II if no downgrading factors are present.
- Drained transforming mires are normally classified into a higher taxation class than the corresponding undrained mires but in a lower taxation class than mineral soil forests of similar site fertility class.
- On pine or spruce dominated natural or drained mires, where the drainage effect is not yet visible, it is not necessary to stick to the above given coding, if the wood productivity of the stand corresponds to a higher (in spruce dominated mires also lower) taxation class.

Taxation class specification code

Taxation class specification is used if the assigned taxation class differs from what it should be according to the site fertility classification; on mires according to the principal

site fertility classification. Specification code is used if the change is at least one taxation class.

0 No specification (no change).
1 Close to the solid rock, stony soil.
2 Paludification, wetness: mineral soil forest is paludified if 25-75 % of the ground vegetation is of peatland vegetation. This code is also used when a drained transformed mire is classified into a lower taxation class than the corresponding mineral soil forest.
3 Very thick raw humus layer (> 8 cm): normally only present in the site fertility class 3, in Peräpohjola region also in the class 4.
4 Location: low temperature sum, windiness or frequent snow damages in high land areas and at shores of the sea or big lakes.
5 Other factor that downgrades the taxation class.
6 Natural peatland or peatland slightly altered by drainage classified into a higher class than expected by the site fertility class and drainage stage.
7 Drained transforming mires: the taxation class is the same as that of the corresponding mineral soil forest.

3.3 DESCRIPTION OF GROWING STOCK

General

Description of growing stock is recorded by stand and tree strata on forest land. The data for forest stand consists of following: number of tree storeys, stand development class and main tree species, severity of forest damage and stand quality. The separation of trees into tree strata is based on tree storey class, species, and origin (only in seedling stands). Each tree stratum is described with its own mean attributes; in seedling stand the trees are also separated by origin. Tree stratum data are collected according to soil type and/or development class and storey position (see Table 5). On poorly productive land only the dominant tree species in storey is recorded. On unproductive land no tree strata data are collected.

According to the new Forest Act, small gaps as part of uneven aged forest management are considered as their own stands if they are large enough (minimum size of the NFI stand is 0.25 ha), otherwise they are included in the surrounding stand - practically the nearest quarter hectare. To help the identification of uneven aged forest management, the planned felling method is searched in advance and informed at the top of the topographical map. Notifications made after the pre-check can be checked with the phone app. The description of stand and growing stock is done in relation to the size of the small opening and the location of the plot as follows:

If the plot is located in a small gap and does not include trees from the wooded part, growing stock description comes
- from the gap if it is large enough to be a stand
- from the nearest quarter hectare if the gap is too small to be a stand

If the sample plot is located in a small gap and it includes trees from a wooded part, stand description is done
- from one stand (nearest quarter hectare) if the gap is small
- from two stand (gap and wooden part) if the gap is large enough

If the plot falls on a wooded part and the nearest quarter hectare has a small gap, it is
- taken into account in the stand and growing stock descriptions if the small gap is small
- not taken into account if the small gap is it's own stand

The same criteria are used for tree storey classification as before, i.e. tree storey is not described as tree strata if there is not the required amount of trees. Regardless of the tree storeys, it is possible to record a forest damage for a tree storey that is lost as a result of the damage. The criteria for the description of the tree storey class are presented later.
Tree storey classes are as follows: dominant, upper, and lower tree storey. Upper tree storey may consist of shelter trees, over-storey trees, and retention trees (Table 4). Lower tree storey is further divided into three classes: 1) trees can development (i.e. grow) further, 2) not develop further and 3) unstable seedling materials.

Upper and lower tree storeys are separated from the dominant storey in the following cases:
a) if the volume/stem number of the storey is large enough,
b) if the tree storey has effect on the future silvicultural treatments (e.g. under-storey that must be removed before the next cutting), or
c) if mean variables of the growing stock is difficult without describing separate tree storeys.

The difference in the mean age between tree storeys should be at least 40 years. The difference in age may be less if two layers are of different species and clearly different mean height. On the other hand, the range of tree ages may be more than 40 years in one tree storey, in some cases. For example, naturally regenerated stands on poor sites may have large age variation within the same tree storey. Uneven aged forest stand is not divided into tree storeys.

Within the older tree storeys (stand development classes 4–8) each tree species get their own tree stratum, if the species' basal area is at least 1 m2/ha or 5% of the total (stand) basal area. If there would be more than 4 records per a tree storey, we can combine similar species data in terms of mean attributes. If we need to combine species into one record, then the species code is the dominant species in this record.

In young stands the tree strata are based on by separating species and origin (planted/other). Origin gives us information to separate those seedlings and saplings that are allowed to be further growing in a managed stand. If the stand is not regarded to be capable for further development, the origin is not a criterion for further grouping, and the origin can be marked according to the most common origin (class) of trees.
In collecting the data, first we fill in those tree strata which contain seedlings for growing. In young stands capable for development, each tree species (with number of trees at least 200 /ha or the share of seedlings is remarkable, i.e. at least 10%) gets its own tree stratum. The less abundant species can be combined into another corresponding

species record. However, conifer and broadleaf species cannot be combined into the same tree stratum.

The lower limit to establish a tree storey is 400 trees/ha, so if there are a smaller number of seedlings in a stand it is marked as ‘not capable for further development’, and then the number of seedlings to grow is not collected. However, the tree stratum for seedlings ‘capable for further development’ can also contain seedlings that are regarded as ‘not capable’ (in the field ‘number of seedlings’), but all other data are collected for potentially capable seedlings (as height and age).

Those tree species which do not have a sufficient number of seedlings for a record, the team collects only one common tree stratum for all species, and the tree species of the record is the dominant species. However, conifer and broadleaf species cannot be combined into the same tree stratum. If in a young stand which is regarded as ‘not capable for further development’ there are seedlings/saplings with varying heights and it is difficult to estimate just one mean height, then the team collects data by multiple tree strata.

Number of tree storeys LUC: 1-2

Maximum of three tree storeys can be separated for each stand. Open clear cut area can be described as two or even three tree storeys stand. A clear cut area can contain retention trees or seedlings, however on an open clear cut area is the dominant tree storey is always as "treeless storey" and the wooded tree storey is the second.

The stand is regarded as uneven-aged stand if the growing stock consists of trees with different ages and sizes, and clear tree layers cannot be observed. In such cases, the stand has been either managed as uneven aged forest or it has naturally developed as uneven-aged forest, and it cannot be transformed into even-aged forest with thinning. In uneven-aged stands the growing stock is described in the same way as in single storey stands. Naturally uneven aged stands (e.g. poor sites) are described in the same way as in single storey stands (usually development class *advanced thinning stage*). The development class of stands managed with uneven aged forest felling is "uneven aged" and the stand is described by size classes of growing stock (thinning stage or mature and seedling strata) if the stand structure is uneven aged or evolving towards it. If the felling method is not changing the structure to uneven aged, the structure is recorded as evenaged forest, regardless of the felling method of the forest use notification. Small gap felling typically changes the structure of the stand, at least in the initial stage, into two-storey, not to uneven aged.

0 Uneven-aged
1 One storey
2 Two storeys
3 Three storeys

Development class of the dominant tree storey LUC: 1

1 *Non-stocked regeneration area* is treeless or there are only single standing trees and/or trees that should be removed in clearing of the regeneration area. There may grow clusters of seedlings on non-stocked regeneration areas. This area can also contain single tally trees, retention trees (to be recorded as separate storeys), or young coppice trees. All these are recorded as under-storey tree strata.
2 *Young seedling stand* is recorded if the mean height of the species (to be left to grow) is less than 1,3 m.
3 *Advanced seedling stand* is recorded if the mean height is more than 1,3 m. Most of the dominant trees (trees that will be not removed in the thinning) are less than 8 cm in diameter and the largest trees are less than 10 cm. The mean age (at the breast height) of the dominant trees is not more than 50 years in South Finland and not more than 120 years in North Finland.
4 *Young thinning stage stands* is recorded if the growing stock is relatively young, and at the stage of the first thinning. The drain will consists is mostly of pulp-wood size timber. The minimum limit for the mean age (at the breast height) is

11 years and maximum limit is 120 years in South Finland, and 200 years in North Finland.

5 *Advanced thinning stage stand* consists of growing stock where trees are older and bigger than in the previous class. There are some log-size stems, included also into the harvest. The minimum mean age (at the breast height) is 20 years, and the maximum is 140 years in South Finland, and 200 years in North Finland. If the site fertility is too poor, or the species is not suitable for the site to produce log-size stems, the development class is determined mainly with the help of the trees' mean age.

6 *Mature stand* means a stand that is either old and/or large enough for regeneration cutting, but the cutting has not yet started. The maturity status for regeneration is primarily determined with the help of the age of growing stock (see Table 3). If the mean diameter is greater than the minimum diameter limit presented in Table 3, the regeneration cutting may be done before the minimum age limit.

7 *Shelter tree stand* is a stand with natural regeneration below the shelter trees, usually containing 150–300 shelter trees per hectare. In some cases the density of the shelter tree layer is so tall that these trees must be removed in two stages. Shelter tree stand is usually created as a result of a regeneration cutting (not by natural processes). The need for planting or seeding determines whether a shelter tree stand is regarded as unproductive or productive for timber production.

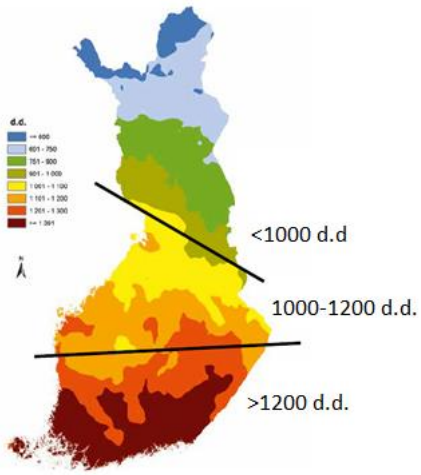
8 *Seed tree stand* is so-called natural regeneration area, usually with 30–150 fairly large stems per hectare (minimum in birch stands is 10–30 trees/ha). A normative limit for the maximum basal area for a seed tree stand is 5 m^2/ha.

9 *Uneven aged stand.* A forest that already has an uneven aged structure because of management or is developing towards it. The stand is not divided into distinct tree storeys, but consists of trees of different ages and sizes.

Table 3. Minimum age and mean diameter threshold values for stand maturity. (Hyvän metsänhoidon suositukset 2014)

Tree species	Site fertility type	Forest maturity, minimum limits			
		Age	Mean diameter	Age	Mean diameter
		>1200 d.d.		**1000-1200 d.d**.	
Pine	Fresh heath	70-90	26-32	80-100	24-28
	Rather dry heath	80-100	25-30	90-110	23-27
	Dry forest	90-120	22-26	100-130	22-25
Spruce	Grove-like heath	60-80	28-32	70-90	26-30
	Fresh heath	70-90	26-30	80-100	25-28
Silver birch	Grove-like heath	60-70	28-32	60-70	27-30
	Fresh heath	60-70	27-30	60-70	26-28
Downy birch	Mineral soils	40-50		40-50	
	Peatlands	50-60		50-60	
		750-1000 d.d.		**<750 d.d.**	
Pine	Fresh heath	90-120	23-27	100-130	22-26
	Rather dry heath	100-130	22-26	110-140	21-25
	Dry forest	120-150	21-25	130-160	20-24
Spruce	Grove-like heath	100-130	23-26	110-140	22-25
	Fresh heath	110-130	22-25	120-140	21-24
Silver birch	Grove-like heath	50-60	21-23	60-70	20-22
	Fresh heath	50-60	21-23	60-70	20-24
Downy birch	Mineral soils	40-50		50-60	
	Peatlands	50-60		60-70	

Effective temperature sum map (1981-2000) (Hyvän metsänhoidon suositukset 2014)



Main species of the dominant tree storey LUC: 1–2

The main species of the dominant tree storey is determined based on dominancy of the coniferous and broadleaf species. In conifer (dominant) stand the main species is always a conifer, and in broadleaf (dominant) forest the main species is always a broadleaf

species, respectively. If the proportions are equal in a tree storey, then the dominant species is determined by selection the species group which is the main growing stock in the future treatments. In stand development classes 4–8 and on poorly productive forest land the dominance between conifers and broadleaves is determined by selection that group which has greater basal area (i.e. more than 50%). The main species is that conifer of broadleaf species which has the greatest proportion of the basal area of the storey.

In young stands regarded as 'capable for further development' and which belong to the stand development classes 2–3, the dominancy between coniferous and broadleaf species is determined which one has a greater number of the growing seedlings (/ha). In this can we can use data about the recorded number of seedlings and proportions of species. When we determine the main species, it must be taken into account that in young stands with 'capable for further development' the maximum proportion of naturally born (additional) seedlings cannot exceed 20% of the total number of seedlings.

In underproductive young stands the dominancy between coniferous and broadleaf species is determined among seedlings which would be selected to stay and grow in the stand, if the stand would be harvested (thinned) into the 'normative' density. If the dominant layer's development class is 'open land', the main species is always 0 (treeless).

Tree species codes:

0 Non-stocked (treeless)	A1 *Pinus contorta*	B1 *Salix pentandra*
1 Scots pine	A2 *Pinus sembra*	B2 *Ulmus glabra*
2 Norway spruce	A3 Other pine	B3 *Ulmus laeva*
3 Birch, *Betula pendula cordata*)	A4 Larch	B4 Alm (*Tilia*
4 Birch, *B. pubescens*	A5 Fir	B5 Poplar
5 Aspen	A6 Other spruce or fir species	B6 *Fraxinus excelsia*
6 Grey alder (*Alnus incana*)	A7 *Thuja occidentalis*	B7 Oak
7 Black alder (*A. glutinosa*)	A8 Juniper	B8 *Prunus padus*
8 *Sorbus aucuparia*	A9 *Taxus baccata*	B9 *Acer platanoides*
9 *Salix caprea*	A0 Other conifer	B0 Other deciduous

Development class of undergrowth storey **LUC: 1**

As development class of the dominant tree storey.

Main species of undergrowth storey **LUC: 1**

As main species of the dominant tree storey.

Development class of over-storey **LUC: 1**

As development class of the dominant tree storey.

Main species of over-storey **LUC: 1**

As main species of the dominant tree storey.

Basal area of the stand **LUC 1–2**

The number of relascope trees determined from the five observation points, the location information of each observation point, the average basal area of the stand (including basal area of another tree storey) and the basal area of another tree storey are recorded as the basal area data of the stand. Three observation points are enough on non-stock regeneration areas, seedlings, seed tree and shelter tree stands and secondary stands. On poorly productive forest land, only the basal area of the stand is recorded.

Basal area measurements are made primarily from the center of the plot and the main air directions at a distance of 20 m from the center. Of these fixed points, at least three measurements must be made on each stand, if this is possible within the stand boundaries and shape of the stand (the measuring point is invalid if it partially or completely locates on another pattern). The other two measuring points can be selected subjectively. The number of subjectively selected points may be even higher if three observations cannot be measured from the fixed points.

Measurements are made on full circles that fit completely into the stand they represent. The basal area can be measured from a semicircle only if the shape of the stand is such that it is unreasonably laborious to fit full circles on it.

Number of relascope trees **LUC 1**

Relascope trees and the basal area of the stand always include all living trees, regardless of diameter, tree storey and canopy layers. Relascope trees are defined using a relascope with a factor of 2 throughout the country. If the number of relascope trees has had to be determined using a half-icircle (e.g. narrow edge-of-field stand), multiply the number of trees by two before recording.

Location of relascope measurement point **LUC 1**

Location of relascope measurement point from the center point:

0 Full circle at the center of the plot
2 Observation 20 meters to East
4 Observation 20 m to South
6 Observation 20 m to West
8 Observation 20 m to North
9 Other observation point

Stand basal area (m^2/ha) **LUC 1–2**

The data entry program calculates the average stand basal area from the number of relascope trees. If this does not correspond to the actual stand basal area, additional observations (not recorded) must be measured and the average basal area calculated from the recorded observations must be changed.

In a two-storey forest, the stand basal area includes the basal areas of both storeys.

Tree strata

Tree stratum number **LUC: 1–2**

The data entry software gives a new running number (1,..) for a tree stratum.

Position in tree storey class **LUC: 1–2**

Trees position in tree storey class describes the position of trees within all tree storeys or inside one storey.

0 Unproductive seedlings in a dominant tree storey. Valid code only for young seedling stands.

1 Dominant tree storey / seedlings to grow in a seedling storey. In older stands, no shelter trees exist / main size class of uneven aged stand

2 Over-storey, which consists neither of retention trees nor nurse crop trees. At least some of the over-storey trees can be seed or shelter trees, or trees that are obviously left for growing. This class includes also seed or shelter trees that are no longer needed for the development of the dominant (lower) storey up to the point of time, when they can be removed without serious damages to the dominant (lower) storey. After this, these trees are regarded as retention trees.

3 Retention tree storey is recorded when the tree storey consists of trees of merchantable size. There must be at least 10–30 trees/ha, and the basal area should be at least 1m2/ha. The trees should be located rather evenly on the stand, or in several clusters. Individual retention trees, dead trees and non-cleared small trees after harvest are not described as retention trees. Retention tree storey may also consist of seed and shelter trees that have been left untouched after other management operations on the site.

4 Nurse crop consists of deciduous trees. It has been cut and left into such density that it can protect the existing or future (planted) spruce seedlings

from the frost. A nurse crop stand before planting of spruce is described in the similar way as the dominant storey, as one storey stand.

5 Under-storey capable for further development is recorded, if
1) the number of seedlings is greater than the minimum number of seedlings for productive stand (presented in Appendix 10), or
2) the number of seedlings is less than the minimum limit in Appendix 10, but the seedlings will obviously support the regeneration. In this case there should be at least 400 potentially good seedlings per hectare, and these seedlings should locate in the stand in such way that a part of the stand can be left untouched (i.e. no soil preparation and/or planting).
Under-storey should contain species that are suitable to grow on the site and the upper storey should not be so dense that it can be destroyed in a timber harvest Usually, under-storey seedlings emerge continuously on the site. Often in these cases, a regeneration cutting will be proposed for the coming 10 year period; planting/seeding can be recommended on regeneration areas.
Under-storey capable for further development can consist also of tree storey which were naturally born under the dominant tree layer, but passed the young stand stage. In this case the basal area of the trees should exceed the minimum limit set to the stand ‘capable for further development’.

6 Under-storey ‘not capable for further development’ is recorded if the tree storey cannot be managed to become a productive growing stock. The reasons can be as follows (but not limited): 1) species is unsuitable for the site, 2) damages have (partly) destroyed the tree storey, or 3) the upper storey canopy is so dense that the removal of the upper storey trees will destroy the under-storey seedlings. Under-storey not capable for further development is recorded only if the number of seedlings is greater than the minimum limit presented in Appendix 10.
Under-storey not capable for further development can consist also of tree storey which were born under the dominant tree layer, but passed the young stand stage. If the trees position in tree storey class code is 6, the number of seedlings to grow is set to 0.

7 Non-established seedlings showing regeneration capability of the site is recorded when these seedlings are of suitable species for the site, but the density of the upper-storey prohibits the development of these seedlings.

Tree storey class positions used since NFI12:

8 Damaged tree stratum. There has been severe forest damage and as a result the stand has completely died and / or disappeared, or the stratum may have been removed after damage. The damage will not be described within any other forest stratum. Only the tree species and damage data are recorded for the stratum. The emphasis is on thedamages of the last 5 years, but even older damages can be recorded.

9 Seedling stratum of uneven aged stand. Management developing the stand towards uneven aged structure has been performed and the development class of the stand is 'uneven aged'. Dominant tree storey of larger trees is described as position 1 stratum.

Table 4. Possible occurrence of over-storey and under-storey tree layers by development class.

Position of the storey	development class of the dominant tree layer
0 Unproductive seedlings	2–3
2 Over-storey	2–5
3 Retention trees	1–4
4 Nurse crop trees	2–3
5 Under-storey capable for further development	1, 3–8
6 Under-storey not capable for further development	3–8
7 Non-established seedlings	5–6
8 Damaged tree stratum	1-8
9 Seedling stratum of uneven aged stand	9

Table 5. Variables required according to tree storey position classes

	Storey position									
Variable	0	1	2	3	4	5	6	7	8	9
species	x	x[k]	x	x	x	x	x	x	x	x
origin	x	x	x		x	x				x
mean diameter[3]	x	x[k]	x	x	x	x	x			x
mean height	x	x[k]	x	x	x	x	x			x
age	(x)	x[k]	(x)	(x)	(x)	(x)				(x)
basal area	x	x[k]	x	x	x	x	x	x		x
no. of seedlings to be grown [1]		x				(x)				(x)
no. of seedlings, total	(x)	x	(x)[2]	(x)[2]	(x)	(x)	(x)			(x)
damages	x	x	x			x	[x]		x	x

(x) = ocular estimate

[x] = damage recorded only if has caused that the storey is not capable for further development

1) recorded if development class is seedling

2) small amout of over-storey

3) not recorded if development class is young seedling

k) position of tree storey always 1

Species **LUC: 1-2**

The species is coded with the same codes as the main species of the storey.

Origin **LUC: 1**

Origin of the stand separates the planted stands from the naturally regenerated stands. Separate seedling stratums are recorded if there are both natural and planted or sown seedlings within a stands. Origin is recorded only for the development classes 2–5 and 9.

0 Open or development class 6–8
1 Naturally regenerated from seeds
2 Naturally regenerated, coppice
3 Planted
4 Sown

Mean diameter, cm **LUC: 1**

The mean diameter is defined as the mean of living trees' diameters, weighted by tree basal areas, which is approximately equal to the diameter of the basal area median tree. On a relascope plot this mean diameter is equal to the arithmetic mean of diameters of the tallied trees. Mean diameter is not recorded on young seedling stands.

Mean height, dm **LUC: 1–2**

The mean height is recorded as the height of the basal area median tree (among live trees in the tree stratum). In seedling stands 'not capable for further development' the mean height of seedlings is the mean height of the seedlings that would be left for growing after next tending. The unit of the recording is dm.

Age **LUC: 1–2**

Age of the growing stock is computed by summing up the age at the breast height and the age when the breast height was reached. The age is recorded on forest land and poorly productive forest land as years. The age of the dominant tree storey must be measured, otherwise it can be estimated visually. The age is not recorded for tree storeys with position codes 6 or 7 ('under-storey not capable for further development' and 'non-established seedlings', respectively). The (current) year of the measurement is added into the age.

Age at the breast height

The precision of the recording is 1 year. For the stands which belong to the development class 3, the age is defined as the mean age of the seedlings of the future growing stock. In development classes 4–8, the age is defined as the mean weighted by basal area of the trees.

The age at breast height is measured from cores taken at 1.3 m height (later called as age cores) or counting of the annual branch whorls. In the older stands the age needs to be measured from more than one tree. However, in the even-aged planted stands, just

one measurement may be sufficient. If the annual rings cannot be seen without microscope, the age will be counted in a laboratory.

The age at the breast height is recorded into the variables IKALASTU and D1.3-IKA into the field computer. IKALASTU-variable is used to explain whether the age has been calculated in the field or the age core has been sent to the laboratory.
IKALASTU:
E observed in the field,
K to be measured in the lab.
If the age core is sent to the laboratory ('K'), is the estimated age recorded into D1.3-IKA.

If the age is to be measured in the lab, the plot and stand identifications must be clearly marked on the age core. The code 'K' must be added to indicate that the core will be used for defining the age. In addition, the tree stratum should be marked: add 'O' and the corresponding tree stratum number.

Note, that it is possible to use an increment core of a sample tree as an age core for a stand. For instance, letters '12-1-K1-O1' means that the core sample is from the plot 12, tree 1, stand 1, and tree stratum 1. If a sample represents more than one tree strata, then it can be marked as follows: 12-1-K1-O1,4

Note: On permanent plots it is not allowed to bore the trees. The age core must be taken from those trees which stand at least 15 meters from the plot center.

Age when the breast height was reached

The age of reaching the breast height (level) describes how many years the tree has grown before reaching the height of 1.3 meters. Appendix 13 can be used to determine the age if the growing stock is naturally originated from seeds and the tax class of the site has not changed. If the table (in Appendix 13) can be used, code 'N' is recorded as the code for the age of reaching the breast height. The tree species, tax class of the site and the length of thermal growing season are needed for using the table.

If the stand has been planted or sown, or the trees are coppices, the age of reaching the breast height must be recorded as years. In case of conifers, branch whorls can be used for counting the age. Note, that the time required at the early development stage of the seedlings must also be taken into account.

If the tree storey has not yet reached 1,3 m high, the current age is recorded as the age of reaching the breast height. For non-stocked areas, the age is 0. If the stand has been sown in the year of the assessment, the age is 1.

If the tax class of the site has changed since the trees were regenerated, the current tax class cannot be used in defining the age of reaching the breast height (with the table in Appendix 13). Instead, the tax class at the time when the trees were regenerated must be recorded.

The age for reaching breast height in entered into the data entry software either in years or by selecting the tax class (N, A-E). The codes given for the field computer as the age of reaching the breast height are as follows:

N	Current tax class of the stand can be used for defining the age,
A	Tax class IA must be used for defining the age,
B	Tax class IB must be used for defining the age,
C	Tax class II must be used for defining the age,
D	Tax class III - IV must be used for defining the age,
E	Land use class poorly productive land or unproductive land must be used for defining the age.

Basal area, m2/ha **LUC: 1–2**

Basal area of the stock is defined with five angle-gauge plots at five different sample points. On open areas, young seedling stands, seed and shelter tree stands and secondary plot stands three plots are enough. Basal area measurements are mainly conducted at the sample point and in the cardinal points 20 m away from the sample point.

The measurements are conducted on circular sample points, which completely fit inside of the stand. It is possible to measure the basal area using partial circles only if the shape of the stand does not allow full circle measurements. Basal area is defined using a relascope with a factor of 2 throughout the country.

Number of stems **LUC: 1**

Number of the stems is recorded for the tree strata that belong to the dominant storey, and to under-storey capable or not capable for further development if the these storeys are in a seedling stand. Number of the stems is also recorded for seedling stratum of uneven aged stands. In addition, the number of stems can be recorded for sparse tree group which belong to the over-storey, e.g. for seed or retention trees, if the stem number is regarded more accurate than the basal area estimate and if it is possible to estimate easily.

The number of trees selected for further development is recorded to the dominant storey (position of the storey is 1) and to that tree stratum which is considered as ‘capable for development’. In case of seedling stands, these are recorded to the under-storey (position of the storey is 5), and to tree stratum which is ‘capable for development’.

When defining the number of stems of a dominant storey, the measures are taken from the counting of seedlings (see more at Chapter 3.5). The number of stems for under and over-storeys are estimated by ocular means. The results/estimates can be changed, if the results don´t seem to represent the actual stem number. The recording unit is stems/ha.

The recording precision is 100 stems/ha, if the total stem number is below 5000 stems/ha, and 500 stems/ha if the stem number is more than 5000 stems/ha. The precision for the over-storey recording is 10 stems/ha.

Number of crop seedlings, pcs/ha

Seedlings regarded as the future growing stock consist of actual crop seedlings and complementary crop seedlings (see definitions in Chapter 3.5). The proportion of complementary crop seedlings cannot exceed 20 % of the total of crop seedlings. Recording unit is 100 seedlings per hectare.

Seedlings grown in uneven aged forests needs to be able to recover after fellings and they do not have the same height or distance requirements than the evenaged seedlings. The stem number includes all seedlings in good condition that are at least 10 cm in height and are suitable for the habitat. As a general rule, the height of a recoverable seedling should be at least 5–10 cm / year, and the tree should not be so-called 'opened umbrella'.

Total number of stems, pcs/ha

Small seedlings that will not have any effect on the yield or quality of the stand are not considered in counting of the total numbers of stems.

Damages (max 2 records) **LUC: 1**

A damage is described with following variables: damage type, timing of the damage, causing agent. Degree of the damage is recorded as the sum effect of the all damage agents. Recording principals are the same for damage type, age of the damage and causing agent as for tally trees. If there are several damages, the two most serious damages are described separately, and the more severe damage first.

Damages of the under-storey are recorded only if the damages are affecting on seedling 'capable for development' or seedlings, which were in normal condition before the damage.

Damage type

0	No damage
1	Dead standing trees. There are dead trees or trees that will die before the next growing season.
2	Fallen or broken trees. There are fallen trees or trees that are broken below the mid-point of the live crown. The trees can be dead or living. In addition, trees which lean badly are regarded as fallen trees.
3	Decayed standing living trees.
4	Damages on the stems. Damages that are either on/in the stems or on the roots (no further than 1 m from the stem). The damage cause agent can be e.g. fungi, frost, browsing or harvesting.
5	Flows of resin. Abnormal flows of resin observed along the stem higher than 1.5 m from the stump level (flow lower than this limit are recorded with code 4). The length of the visible flow(s) must be at least 30 cm.

Dead or broken tree tops

61 The top of the tree has got broken. The top has got broken above the upper half of the living crown and tree has not developed a new leader branch.

62 The leader branch is dead. The leader branch of the tree and usually the upper shoots are dead in the upper half of the crown and the tree has not developed a new leader.

Leader die-back or deformed leader. Damages at the top that have not yet developed to damages in trunks (code 4).

71 Leader change caused by leader damage, which has not yet developed to damage in the stem.

72 Multiple leaders, bush formation in the top. Occurs especially among seedlings and young trees, caused e.g. by growth disorder. Flat top of old pines is not considered as damage, unless it is caused by some external factor.

73 Bent top. The leader or the top that was formed during the past few years is strongly bent, curved or drooped.

8 Deformed stem. Sweeps or forks in the stem, caused e.g. by former die-back or poor quality planting.

Branch damages

91 Dead branches within the living crown. The tree has an abnormal amount of dead branches caused e.g. by drought or insects. Dead branches of old trees, which have died long time ago and lost their lateral branches are not counted.

92 Broken branches within the living crown. The tree has an abnormal amount of broken branches caused e.g. by snow or a moose.

93 Deformed or bent branches within the living crown. The tree has an abnormal number of deformed, bent or curved branches caused e.g. by some external factor, e.g. snow or pine twisting rust within the live crown.

A Abnormal dying of branches in the lowest part of the crown. Typically caused by fungi. The normal dying of branches due to competition caused by shadowing neighbor trees is not recorded as damage.

B Loss of needles/leaves or shoots. Fallen needles, leaves or shoots. Falling of needles or leaves caused by normal annual cycle or (male) flowering is not recorded as a damage.

B1 Needles/ leaves/ shoots of current growth season.
B2 Older needles.
B3 Needles of all ages.
B4 Loss of leaves.

C Discolored needles or leaves. Colors of needles/leaves differ from healthy and normal. Variations in colors due to the normal annual growing rhythm are not considered as damages.

C1 Needles of the current growth period.
C2 Older needles.
C3 Needles of all ages.
C4 Discolored leaves.

D Deformed needles or leaves. The needles or leaves are abnormal in terms of size or form, e.g. they are curly or rolled.

Timing of the damage

The timing of the damage describes when the damage started and whether it continues. 'Continuing' means that the damage expands during the current growing season. In most cases this also means the presence of the damage agent and thus it is often related to epidemic fungus and insect attacks. Damage caused by timber harvesting are usually already ended, even though the effect of the damage is still visible.
Frost damage have usually ended unless there are some visible signs of frequent damages, and the stand's development stage is not particularly vulnerable to frost.
Pine twisting rust can be classified as ended, if the needeles int newest shoot are not discolored.
Needle damage caused by insects are classified to continue, if at the measuring time there are still some pests in the trees. An exception is, however, damage caused by pine sawfly: this damage can be classified as ended before the end of July only if two of the newest shoot layers are intact.
Damage caused by rot fungus (e.g. *Heterobasidon sp*.) are mainly continuous.

- No damages
0 Damage started less than 2 years ago. The damage has emerged during the year of the field measurements or during the previous year.
1 Damage started 2–5 years ago, and still continues. The damage is regarded to continue if the causing agent still affects on the growing stock, or the trees have not started to recover.
2 Damage started 2–5 years ago, but passed. The damage has passed if the causing agent does no longer affect on the growing stock and the trees have started to recover, or if the damage has already killed the trees.
3 Damage started more than 5 years ago, and still continues.
4 Damage started more than 5 years ago, and it is passed.

Causing agent

Human intervention is recorded as the causing agent only if the damage has not been caused by purpose. Thus, clearing of bushes (mechanically or chemically) is not recorded as damage.

E No damages
0 Not identified

A Abiotic factors
A1 Wind
A2 Snow
A3 Frost
A4 Other climatic factors
A5 Fire
A6 Soil factors (other than AA, AB and AC)

AA Drought

AB Unbalance of nutrients

AC Wetness, flood. Flood damage caused by a beaver is recorded as B3 and damage caused by mire restoration is recorded as A9.

A7 Harvesting
A8 Air pollution (primary agent of the pollution must be identified, e.g. industry, traffic, agriculture)
A9 Other abiotic or human intervention
A0 Unidentified abiotic factor.

B Animals

B1 *Cricetid* rodents
B2 Elk
BC Other *Cervidae*
B3 Other vertebrate (beaver, hare etc.)
B4 Bark beetles
B5 Pine weevil
B6 Pine sawfly
BA *Diprion pini*
BB *Neodiprion sertifer*
B7 Other needle-damaging insect
B8 Spruce bark beetle
B9 Other identified insect
B0 Not identified insect

C Fungi

C1 *Annosum* root rot (pine: *Heterobasidion annosum*, spruce; *Heterobasidion parviporum*). *Heterobasidion parviporum* causes root rot for spruce and *H. annosum* causes root rot for several tree species. In pine stands, fungus causes also the base get tarred. This agent can be recorded in pine and birch stands, when there are clusters of dying trees, fresh pine stumps have a clear tar pattering, or there are in the stand dead seedlings and junipers, whose roots have rotten and small fruit bodies are visible in the base. In spruce stands, the identification is sure only when shelf fungus is found at the lower surface of the root. White rot on a stand is also quite sure sign of *H. parviporum*. Wide rot damages in spruce stands are usually caused by root rot.

C2 Other rot fungus (e.g. *Phellinus pini, Inonotus obliquus, Fomitopsis pinicola*)
C3 *Scleroderris* canker
C4 Pine twisting rust
C5 Blister rust
CA *Chrysomyxa ledi* needle rust
CB Birch rust
C6 Other rust fungus
C7 Pine needle-cast fungus

CC *Lophodermella* needle cast
C9 Other identified fungus
C0 Unidentified fungus

D Other

D1 Competition. Shadowing or whipping effect caused by neighboring trees or undergrowth. However, neither over-density nor high basal area of the growing stock are regarded as a damage.

Main damage of the stand

0 Not the main damage of the stand.

1 Main damage of the stand. Considering all damages in the stand, the most significant damage in terms of stand quality. When the same damage (appearance, timing, cause) is recorded for several growing stock strata, main damage code is usedfor the stratum where the total significance of the damage is the greatest.

Stand level description of growing stock, part 2

Degree of the damage **LUC: 1**

The degree of the damage is a stand level variable which describes the cumulative effect of all observed damage agents. The estimation of this variable is based on the difference between the current (damaged) state and state of the stand before the damage. The effect of the damage on the growth, mortality and quality of timber are the main criteria for determining the degree of damage. The damage of a totally damaged growing stock stratum is taken into account according to the timing of damage, and if the damage no longer affects the quality of the forest (e.g damaged trees removed), the degree of damage is recorded with a letter code.

E No damages

0 Mild damage. The damage has not affected on the quality or development class of the stand.

1,A Noticeable damage. The damage has decreased the quality of the stand by one class or has made an under-productive stand less productive. The damage has not changed the development class (except possibly destroyed the upper storey on the top of an established seedling stand).

2,B Severe damage. The damage has decreased the quality of the stand by more than one class or has changed the development class into non-stocked category. A stand that was under-productive before the damage has essentially lower productivity because of the damage.

3,C Very severe damage. The stand must be regenerated immediately.

The *stand quality* describes the silvicultural state of a stand. The estimation is based on the stand density, and amount and quality of timber stock on other than regeneration areas. On regeneration areas (on the development classes 1, 7 and 8 and stands with dominant tree storey as the nurse crop position) the estimation is based on the timing and quality of regeneration operations.

When assessing the density of growing stock in thinning stands (incl. uneven aged stands) only those trees that are undamaged, suitable for the site, and larger than 7 cm in dbh are considered (Forest Act 2013).

The assessment of stand quality is done by comparing the stand to a fully stocked managed stand with species suitable for the site, where the proportion of saw timber exceeds 45% (40 in broadleaf dominated stands) (as estimated from the yield). According to principles of good silvicultural practices, the basal area after an intermediate cutting (thinning) should not fall under the limit set in the guidelines. The quality of a stand may be reduced due to factors that decrease the structure of the stock: such as the great proportion of species which are unsuitable for the site, damages or poor technical quality of timber. In addition, delays in intermediate cutting or other procedures can reduce the quality of the stand.

In stands where selective cutting or small gap felling are performed to develop the forest towards uneven aged structure, the quality assessment is based on the quantity and quality of growing stock. In addition, harvest damage and the vitality of trees and seedlings are taken into account when assessing the quality of selectively harvested stands. In estimating the amount of growing stock in stands with small gaps, small gaps are included in the stand until they have seedlings that fulfill the regeration obligation. The large amount of unsuitable trees can reduce the quality of the stand also in uneven aged forest.

The *stand quality* groups the stand into two main categories: *productive* and *under-productive* stands. In *under-productive stands* (excluding regeneration areas), the mean annual yield over the total rotation period is so much lower than the yield of in a managed stand on the similar site, that the stand must be regenerated earlier than defined in the normative management guidelines. The criteria for under-productivity on regeneration areas is described in this manual in the context of quality classes and the limits for under-productivity in seedling stands are presented in Annex 10. In areas cultivated during the year of inventory, the quality of the stand is assessed according to the quality of the cultivation works.

The productive stands are further divided into four quality classes: *good, satisfactory*, and *moderate* and *under-productive stands*. When the stand quality is not regarded as *good*, then we must record the most significant (and the second one also when needed) cause for the quality decrease.

1 *Good*. The dominant species is suitable for this site and the stand has been managed according to the management guidelines and schedules. The number

of stems or the basal area of the dominant tree layers is adequate and trees are distributed evenly in the stand. The density of growing stock is not too high to disturb the further development of trees, and the high age of the trees does not harm the development of the stand.

The basal area is not below the minimum of thinning limit of forest management guidelines. In seedling stands, the number of crop seedlings is at least 90 % of the recommended density (Appendix 11). In advanced seedling stands, the number of crop seedlings exceeds the lower limit for the targeted stem number (Appendix 11) in young thinning stand so that the first commercial thinning will be profitable. If there has been a regeneration cutting (either for artificial or natural regeneration) and the soil preparation and/or clearing of the site has not been done yet, the time from the cutting must not be more 2 years.

2 *Satisfactory*. The structure and density of the growing stock is not as good as in the previous class but thethe site potential is reasonably well utilized. The quality of seedling or thinning stand can be improved through applicable silvicultural operations.

The basal area in a thinning stand is at least 80 % of the minimum of normative lower limit after thinning. The density of the stand may be slightly higher than recommended or the age is slightly higher than what is the recommended normative regeneration age.

The stand belongs into this category also if

- in a seedling stand the number of crop seedlings below the limits of the guideline, but there is no need for complementary planting (see Annex 10);
- in a seedling stand the seedlings are too height for complementary planting, but the stand has enough seedlings to fulfill the required number of stems after the first commercial thinning (Annex 11).

This class includes regeneration areas, where the regeneration felling for natural regeneration has taken place 2-4 years ago and where natural regeneration is considered to succeed in a reasonable time, but the neglected clearing weakens the regeneration process.

3 *Moderate*. The stand is still productive but not in satisfactory or good condition. In case of seedling or thinning stand, it is usually not possible to improve the quality of a stand in this class up to the level of 'good' by silvicultural means. The reason might be too low stand density or uneven distribution of the dominating trees. The low density may be a result of natural process or caused by forest management operations. The basal area of a thinning stand is at least 60% of the minimum of thinning regimes. If a seedling stand is not dense enough and – according to the guidelines - it requires complementary planting, the quality of the stand is regarded as *moderate*. In that case a complementary planting should be implemented. Complementary planting cannot be recommended if the mean height is greater than 0.5 m on site classes 4 or poorer, and if greater than 2.0 m on site classes 3 and on more fertile sites. In these cases the stand quality is *moderate* if the number of seedlings is less than the required number of stems (Annex 11) after

the first commercial thinning, but exceeds the limit for *under-productive stands* (Annex 10).

The stand quality is *moderate*, if there has been a regeneration cutting for artificial regeneration 2–4 years ago and the regeneration operations have not yet been started. Stand quality is also *moderate* in the shelter or seed tree stands where the natural regeneration will probably be successful, but the regeneration is prohibited due to the lack of clearing and soil preparation.

4 *Under-productive*. A stand is under-productive if the yield is so low that it is more profitable to do the regeneration cutting before the normative regeneration age than to grow the stand to the normal maturity age. As a general rule, if yield is less than 60% of the yield of well-managed stand, the stand is under-productive. The lower limits for basal area in thinning stands, that cause an immediate need for regeneration, are presented in Annex 12.

An *under-productive stand* is recommended to be cut either immediately or if the value of the stand still increases, after a short period. A short period can be recommended if trees are about to reach the saw timber or pulp timber size.

A regeneration area is under-productive if the regeneration cutting has takenplace more than 4 years ago and the stand has not yet been planted, or if on a natural regeneration area it is obvious that regeneration is not going to succeed in due time. In pine stands, time for natural regeneration is 4 years in Southern Finland and for spruce stands even 10 years. In Northern Finland, the corresponding times are longer, depending on the latitude. If the recent cutting has been against the management guidelines the stand cand be considered *under-productive* immediately after the cutting. Stands where only few trees are left after a severe damage*are* considered as *under-productive* areas as well, but the development class is determined based on the size and age of the remaining trees.

A seedling stand in itsearly development stage is regarded as *under-productive* if the number of crop seedlings is less than the minimum normative number of seedlings in a stand where complementary planting is recommended (see Annex 10). Seedling stands too old for complementary planting are *under-productive* if the number of seedlings is less than the minimum limit defined in Annex 10. In *under-productive* seedling stands the cultivation has failed and usually this kind of seedling stand has to be re-established, and in this case the management proposal is planting.

Thinning stands may be *under-productive* due to too low density, wrong species or low timber quality. If the relative saw timber proportion exceeds the normative saw timber proportion of tended forest, the basal area is used to determine the *under-productivity*: a stand is *under-productive* if the basal area is less than 60 % of the minimum of thinning limit (Annex 12).

A mature stand may be under-productive due to too low density, wrong species, poor timber quality or too high age. A stand is regarded as over-aged

if it requires immediate regeneration due to reduced growth, high mortality, decaying timber stock or due to other reasons. Criteria for over-age stands are given in Annex 14. Even younger stands can be over-aged if the age is obviously causing mortality or decaying.

Reason of decreased quality (max 2)

The code for reason of decreased quality describes the reason why the quality of the stand was decreased. Two reason codes can be recorded. If the quality of the stand is good, no reason code for decreased quality is recorded. If the most significant reason does not cause the reduction of the quality alone, then the second most significant reason is recorded.

- Quality of the stand is good.

0 There is only one reason for the decreased quality (code used only for the second reason)

1 **Age.** The growing stock is over-aged. Age can be the reason of decreased quality in the development class 6. In too old shelter and seed tree stands the reason of decrease is cutting or neglected management.

2 **Species composition.** Species composition decreases the stand quality if it causes decreased yield (see *Species for future growing stock*, chapter 3.5). For estimation of yield, both growth and technical quality are considered. For example, the saw timber proportion is expected to be very low in *Betula pubescens* dominated stands and species composition can therefore recordeds as the reason for decreased quality. Species composition can cause decreased quality in the development classes 2–6 and 9. In the development classes 7–8 the cause is cutting (if wrong tree species has been left as seed trees).

3 **Overstocked**. Over density of the growing stock is recorded as the cause of decreased quality if too high number of dominant tree story stems per hectare has caused loss of vitality and decreased increment of trees. There is an immediate need for a cutting operations. Over density may cause decreased quality in development classes 3–6 and 9 and it usually decreases the quality at most to moderate.

4 **Neglected management**. Neglected management is recorded as the cause agent when the necessary management operations, soil preparation operations or regeneration operations are delayed or have been neglected, and when the over-density of a tree story other than dominant tree story has caused decreased stand quality. Open treeless areas other than those caused by a damageusually fall into this class. Delay in removal of over-storey trees (e.g. seed trees) fall into this class, as well as failure natural regeneration as a result of neglected clearing or soil preparation. Neglected management is usually the main reason in the development classes 1–4 and 7–9, but may also in occur in classes 5–6. In the development classes 4–6, a neglected

management typically decreases the quality of the stand at most to the *moderate* level.

5 **Under-stocked**. Too low density of growing stock decreases the quality in stands where the basal area or the number of crop seedlings per hectare is too low, and the low density has not been caused by operations (i.e. cuttings, tending of a seedling stand). In the development classes 2–4 the common reason is unsuccessful regeneration. Under-stocked stands in the development classes 5–6 (where the latest cutting has been done over 30 years ago or the stand was sparse already before the cutting) fall into this class. Too low density of growing stock may be used as a reason for decreased quality in the development classes 2–6 and 9.

6 **Cuttings**. The technical quality of the growing stock is poor or stand density is too low because of cuttings in the near past (at maximum 30 years ago), or because of tending in a seedling stand. In the development classes 2–6, wrong selection of removed trees and too strong thinningn are the most typical cases. A stand with too dense logging/skidding road network falls into this class. This class includes also seed or shelter tree stands, where the success of natural regeneration is questionable because of poor quality of seeding trees (poor technical quality, age or number of the trees etc.). Cutting may be the cause of decreased quality in all development classes.

7 **Uneven growing stock** decreases the quality in stands where the trees are located in clusters, unevenly or trees are clearly of different sizes, and the spatial distribution is not the result of previous cuttings or other operations. The basal area or the density of the growing stock may be high enough but the poor spatial distribution reduces the timber yield. Usually some silvicultural cuttings would be necessary, but the stand cannot gain good quality level with the help of the cuttings. The code can be used in the development classes 2–6 and 9. This code can be used also in stands that are managed with uneven-aged management.

8 **Technical quality**. The percentage or quality of saw timber (current or future) is reduced due to branches, sweeps or strong tapering of the stems. Decay and scars are recorded as damages (code 9). The code can be used in the development classes 3–6 and 9.

9 **Damage**. The increment or percentage of quality timber is essentially reduced because of damage. This class contains also stands where salvage cuttings have lead into too low basal area of the growing stock. Open areas as the result of damage, and shelter and seed tree stands destroyed by a damage agent fall into this class. The code can be used in all development classes.

3.4 STAND MANAGEMENT

Accomplished measures

Accomplished cuttings LUC: 1–2

Data on the three most recent cuttings during the past 10-year period can be recorded. The data are recorded in reverse chronological order: the most recent cutting is recorded first, followed by the possible second and third most recent cutting. A cutting is recorded only if it affects to the whole stand, except in case of 'special cutting'. Removal of few single trees is not recorded as a cutting.

Codes 3 to 9 and A are for fellings in even-aged managment. Seedling stand management options (codes 1 and 2) can be used in both even-aged and uneven-aged management. Codes E and P are fellings related to uneven-aged forest management, but code E may be used for a selective cutting accomplished in even-aged forest.

Information on planned fellings on the basis of Metsäkeskus forest use declarations has been added to the cluster maps (see Annex 22). The information is primarily intended to identify fellings related to uneven-aged forest management, but it can also help in determining the timing of fellings. If a recent felling is observed, but there is no forest use declaration information on the map, the up-to-date forest use declaration can be checked using the Forest Center web service. The forest use declaration is valid for 3 years, so the felling may be more recent than the felling declaration.

For stands located in *poorly productive forest*, codes 0, 1, 6, A, E, P and S can be used.

0 No cutting during the past 10-year period.

1 Tending of a seedling stand. The class includes both pre-commercial thinning and cleaning of a seedling stand. This class also includes the removal of nurse crop trees, if the cutting does not yield any timber. The *clearings before cuttings* falls into *other accomplished measures* category (see later this variable).

2 Tending of a seedling stand, using spot cleaning method. Only the nearest trees, which harm the development of the crop seedlings, are removed around the crop seedlings.

3 First thinning. The first thinning (inter-mediate cutting) means the first commercial thinning. Most of the removed trees are pulp timber size stems.

4 Other thinning. A thinning other than the first commercial thinning.

6 Removal or thinning of over-storey trees. This class covers removal of seed or shelter trees, also in the case of unsuccessful natural regeneration. Removal of a nurse crop is recorded with this code too if the cutting

yielded timber. Otherwise, the removal of a nurse crop is recorded with code ‘1’.

7 Regeneration cutting for artificial regeneration. Clear cutting.

8 Regeneration cutting for natural regeneration. Seed or shelter tree cutting, or strip cutting.

9 Nurse crop cutting. Cutting that has created a nurse crop, usually to protect spruce seedlings.

A Special cutting. Includes salvage cuttings, opening for roads or ditches, cutting required because of the maintenance of a road or power line. This class also includes cuttings in the nature conservation areas; these cuttings can be done to maintain special features of the site, e.g. restoration cutting in mires or cuttings made to increase the stock of dead trees.

E Selective logging of uneven-aged stand. In the felling, the dominant canopy layer of the forest has been removed, but no small gaps have been made. The aim of the felling is to develop the forest into uneven-aged structure or to maintain the existing structure in it. Clear selective logging in even-aged stands are also recorded in this category, but upper-layer thinnings are recorded as thinnings.

P Gap felling. Stand has been managed with gap felling (small openings, at maximum of size 0.3 ha). Harvesting may involve thinning or selective felling in the areas between the gaps.

S Removal of growing stock on low-yielding drained bog. The obligation to regenerate under the new Forest Act does not apply to drained peatlands that are still poorly productive or unproductive. The code can also be used on forest land when the taxation class is 4. According to the Foreste Act at least 20 trunks / ha must be left, but otherwise the growing stock can be removed without the obligation to regenerate.

Timing of the completed cuttings

Time is estimated as harvesting seasons. The length of a harvesting season is one year, starting from the first of June. If the latest cutting was more than 10 *harvesting seasons* ago, the estimated timing is recorded, even though cutting methods are not separated.

0 The ongoing field season
1 The harvesting season before the ongoing field season.
2 Two harvesting seasons ago.
3 Three harvesting seasons ago.
4 Four harvesting seasons ago.
5 Five harvesting seasons ago.
6 6–10 harvesting seasons ago.
A 11–30 harvesting seasons ago.
B No cuttings observed or time from the most recent cutting more than 30 harvesting seasons.

Quality of the completed cuttings

The quality of the felling is assessed in the case of thinnings or uneven-aged forest cuttings (codes 3–4, E or P) if at maximum 5 harvesting seasons have passed since felling. If there has been a storm damage after the cutting, this should not reduce the quality class of the completed cutting(it is addressed in the context of the damage and stand quality assessment).

0 Not assessed because the cutting method is not 3, 4, E, or) or more than 5 harvesting seasons since the most recent cutting.
1 The felling has been carried out in accordance with current forest management guidelines.
2 Under-stocked. The growing stock is below the forest management recommendation. Only undamaged, viable trees suitable for the site type and at least 7 cm in diameter of breast height are considered as growing stock in this assessment. Small gaps are included when determining the basal area, if the regeneration obligation is not yet fulfilled.
3 Unrecoverable. The felling is done in such a way that the recovery capacity of the remaining growing stock is weak.
4 Stem or root damage. During felling or forest transport, the remaining trees have been damaged, reducing the quality of the forest.
5 The growing stock after thinning is over-stocked for the future development of the forest. However, the reason for the quality reduction is typically overcrowding, not felling.

Accomplished soil preparation measures LUC: 1

The most recent soil preparation measure completed during the past 30-year period is described. Alphabetic codes are used to note that prescribed burning has been applied in addition to the soil preparation. Shallow drains in mounding with ditches are not recorded as accomplished soil preparation measures, but if the ditches are as deep as common draining ditches at the whole stand and the water is conducted like in common ditching, the measure is recorded also as an accomplished draining measure. Mounding (code 4) is recorded, when the seedlings have been planted on the top of mounds.

Information on planned soil preparation based on forest use declarations is recorded in cluster map (see Appendix 22). The accomplished soil preparation may differ from the prior information.

0 No soil preparation
1, A Harrowing
2, B Scarification
3, C Ploughing
4, D Mounding
5, E Mounding with ditches
6 Prescribed burning

Timing of accomplished soil preparation

The timing is recorded in years.

- No soil preparation during the past 30 years
0 The ongoing calendar year
1 The previous year
2 2–5 years ago
3 6–10 years ago
A 11–30 years ago

Accomplished cultivation LUC: 1

Accomplished cultivation describes the cultivation method and its success. If there has been several cultivation measures, the latest one is recorded. There is no time limit for the recording, accomplished cultivation is recorded whenever observed. For mature forest stands, the success of cultivation is not recorded.

In seedling stands, the cultivation is regarded as *failed* if the number of cultivated seedlings is less than according to normative "under-productivity limits" (Appendix 10). If all - or almost all - of the cultivated seedlings have died, either the development class has changed from seedling stand to *open regeneration area* or an upper-storey has become dominant. In such cases, the development class can be either 1, 7 or 8 and *failed* cultivation is recorded. In the development classes 4 and 5 a failed cultivation is recorded, if there are so few cultivated trees that their basal area is less than the limit for *under-productivity* or if their timber percentage is too low set for a *productive forest*.

Information on planned cultivation based on forest use declarations is printed in the cluster map (see Appendix 22). The accomplished cultivation may differ from the prior information.

0 No cultivation
1 Planted, successful
2 Sown, successful
3 Planted, failed
4 Sown, failed

Timing of cultivation LUC: 1

- No cultivation
0 The ongoing year
1 The previous year
2 2–5 years ago

3 6–10 years ago
A 11–30 years ago
B More than 30 years ago

Cultivated species **LUC: 1**

The tree species in the previous described cultivation (no time limit) or the species born by natural regeneration when there has been a regeneration cutting for natural regeneration during the previous 10 years. The regeneration species is coded as '0', if no cultivation has been accomplished or there has been no regeneration cutting for natural regeneration during the past 10 years. The recording is done using the same codes as describing the tree species composition.

Other accomplished measures **LUC: 1**

The latest other operation (than cutting) during the past 10-year period is recorded as *other accomplished measure*. The operation code is recorded only if this measure covers approximately the whole stand (with an exception: *complementary planting*). Harvesting of energy biomass (codes 5–7) means commercial harvesting (harvesting residues, stumps or entire stems with branches) for energy production, not collection of fire wood for private use.

0 No other measures.
1 Complementary planting in a cultivated stand.
2 Complementary planting in a naturally regenerated stand.
3 Pruning. Pruning for timber quality improvement. Recorded only for the development class 4, or older classes.
4 Clearing for harvesting with timber harvesting machines. Recorded only if the clearing has been accomplished as a separate measure and the actual harvesting has not yet started. If the cutting has already been accomplished, the clearing is not recorded.
5 Harvesting of cutting residues or whole tree harvesting for energy production (biomass).
6 Harvesting of stumps for energy production (biomass).
7 Harvesting of both cutting residues and stumps (codes 5 and 6 together).
9 Restoration. Removing of conifers to maintain diversity in *herb rich forests*, small-scale gap opening, burning of standing trees, damaging of trees or other similar measure. The environmental restoration of mires falls into *drainage operations*.

Timing of other accomplished measured

The timing of other accomplished measures during the past 10 years is recorded in years.

- No other measures
0 The ongoing (calendar) year
1 The previous year

2 2–5 years ago
3 6–10 years ago.

Naturalness LUC: 1-3/ center point

The variable describes the state of naturalness of the stand.. The estimation is done in the sample point stands on *forest land, poorly productive forest land* and *unproductive land*. The estimation of '*naturalness'* consists of three factors which are examined and recorded separately: 1) the structure of growing stock, 2) continuum of decayed wood, and 3) signs of human activity. Under each factor, the classification separates natural (or close-to-natural) (0), slightly transformed (1) and clearly transformed (2) stands.

The structure of the growing stock

The growing stock is compared to a typical natural forest at the similar geographical location and within the same development class.

E Not estimated, no growing stock.

0 Natural or close-ton-natural.
Spatial distribution of the growing stock is uneven and the trees are of different sizes. There are tree layers and some trees from the previous generation occur. Minor signs of selection cuttings from the past can be seen, but the cuttings have not effected to the spatial distribution, structure or tree species composition. The dominant trees are old, at least at the mature stage. A naturally regenerated seedling stand after a complete damage may fall into this class, if the damage occurred at mature stand and the trees killed (by the damage) have not been harvested. The class includes also recent fire areas and after forest fire naturally regenerated seedling stands, and areas of new, natural stands formed due to land uplift from the sea.

1 The growing stock is naturally regenerated, its structure differs slightly from natural state, or signs from a slight thinning or removal of over-story trees can be noticed.

2 The spatial distribution of the growing stock is even and the species and size distribution are uniform as the result of (e.g.) cultivation or thinning.

Continuum of decayed wood

The amount of standing and fallen dead wood is compared in relation to the amount of dead wood on the similar site and in the natural state.

E No estimation (land use class 3)

0 Plenty (in relation to the timber production potential of the site) of decayed wood of different ages.
1 Some decayed wood of different ages. In addition, stands with abundant, recently decayed or similarly decayed wood (i.e. the decay state is similar) fall into this class.
2 Only a small amount of decayed wood exists, or not at all.

Signs of human activities LUC: 1-3

The signs of human activity describe the effect of forestry and other human intervention on the natural state of the forest. In peatland forests, the naturalness of water balance must be observed, whether the water balance has any effect on the growing stock and other vegetations. Also ditches outside the plot stand may affect to the water balance. The effects of possible fertilization must also be taken into account as well.

0 No forest roads, no ditches nor effect of ditches outside the stand. Singleold ditches, which have not had any permanent effect on the water balance of the site may occur. No other signs of human intervention, excluding grazing effect or old selective cuttings. The vegetation is not disturbed. The extent of stand in natural and close-to-natural state is large enough to maintain natural processes.

1 Signs of slight thinning or removal of over-story trees or tractor trailss are visible. Some ditches may occur in or outside the stand, affecting the growing stock and on other vegetation. The vegetation is disturbed because of hiking, reindeer (domestic) grazing etc. Other human intervention outside the stand affects the natural processes of the natural like stand.

2 Human interventions, cutting and other silvicultural operations have clearly reduced the natural state of the stand. Vegetation has clearly visible signs of disturbance. Ditching has a clear effect on the water balance and a peatland is transforming or has already transformed to a peatland forest. A stand previously in other land use class than forest has transformed into forest land class, e.g. afforested field.

Cutting proposal

Cuttings can be proposed for the coming 10-year period. If the stand has two tree storeys, it is possible to propose and record two cuttings: the first cutting for the dominant tree layer and the second cutting for the over- or under-storey. Proposal for under-storey is not recorded, if there is no proposal for the dominant storey . Cutting proposed for the over-storey is recorded as the first proposal, if there are no proposed cuttings for the dominant storey. In a two-storey stand, regeneration cutting is marked only for the dominant storey.

The codes and descriptions of the cutting proposals are the same as those for *accomplished cuttings*, with the following exceptions. Tending of a seedling stand can be proposed for development classes 2–4, only. For young thinning stands, tending of seedlings can be proposed only if it the (normative) timing of the operation has already been delayed. *Spot cleaning method* is not as a separate code. Thinning of over-storey is marked a separate code. *Special cutting* can contain only salvage cuttings. *Opening of ditching lines* is not recorded as a cutting even if ditching is recommended for the stand. *Thinning shortly before regeneration* is not proposed. Code B can be applied if the proposed cutting would be without seeding function in case of a regeneration cutting. Thinning cannot be proposed for mature stands.

When considering a thinning need and its timing, the harvest at the estimated cutting time must be taken into consideration. Thinning is usually proposed only if the basal area plus at the proposed cutting time is greater than the normative thinning limit of thinning regimes. Thinning regimes are only normative and especially in young thinning stands, the silvicultural state of the stand is important to consider. Cutting proposal for uneven-aged stands are recorded as thinnings (code 3 if removed trees are mainly fiber trees, code 4 if they are mainly logs). Recommendations and minimum limits defined by law for pre-cutting and post-cutting basal area in uneven-aged stands are given in Annex 12.

Regeneration cutting (in productive forests) can be proposed if the normative minimum age or diameter (for regeneration) is reached. A stand younger than the minimum age limit can be proposed for regeneration only in exceptional cases, e.g. if there are signs of decay, decreased growth or other factors causing exceptionally decreased quality of the stand.

0 No cutting.
1 Tending of a seedling stand. This class includes thinning, cleaning, and spot cleaning of a seedling stand.
2 -
3 First thinning.
4 Other thinning.
5 Thinning of over-storey trees.
6 Removal of over-storey trees.
7 Regeneration cutting for artificial regeneration.
8 Regeneration cutting for natural regeneration.

9 Nurse crop cutting. Cutting that can create a nurse crop.
A Special cutting. Salvage cutting.
B No proposed cutting. Uncut area in a strip cutting stand. The stand is not proposed for regeneration cutting during the next 10 years, because the seedling stand in the strip cutting areas has not yet established.

Timing for proposed cutting

The timing for proposed cutting is recorded for the next 10 year period. If there are two proposed cuttings, the timing will be recorded separately for each operation. If the both cuttings are proposed to take place at the same time, code 'S' is used for the cutting that is less important in terms of the development of the growing stock. The proposal for under-storey cannot be recorded to be more urgent than the proposal for the dominant storey. If the stand quality is regarded as good, the timing of the proposed cutting cannot be Overdue (code '1').

1 Overdue
2 The first 5-year period
3 The second 5-year period
S Two cuttings at the same time

Proposed soil preparation

Proposed soil preparation is recorded for regeneration areas where there is a need for soil preparation. For other development classes (than mature stands) soil preparation can be suggested as a part of the proposed regeneration chain for the next 10 years period. Proposals are not separated as strictly as *accomplished measures* and prescribed burning cannot be proposed.

0 No soil preparation
1 Harrowing or scarification
2 -
3 Ploughing
4 Mounding or mounding with ditching

Proposed silvicultural measures

Proposed silvicultural measures are recorded for the next 10 year period. The proposal is recorded on incomplete and unsuccessful regeneration areas and on other development classes (than mature stands) as a part of the regeneration chain. Need for cultivation is recorded also in *advanced thinning stands*, mature stands and in under-productive stands, if the regeneration cutting has been proposed (for the next 10 year period) and cultivation is the intended regeneration method. Planting and sowing can be recorded using the same code.

Supplementary planting is proposed only if the criteria presented in Appendix 9 are fulfilled. Clearing can be proposed for regeneration areas where the existing vegetation disturbs or prohibits the regeneration, or for under-productive young regeneration areas with no commercial timber drain.

Grass/Weed control is proposed for regeneration areas and seedling stands if there is a clearly visible need for weed control.

0 No silvicultural operations will be needed
1 Cultivation
2 Supplementary planting
3 Weed control
4 Clearing of regeneration area
5 Clearing of regeneration area + cultivation

Variables describing recreational use have been included in NFI13 as new. The purpose of the variables is to obtain information on the number of routes and structures in the forestry land that indicate recreational use, and to estimate the amount of recreational use and the environmental impact caused by it.

The area observed is the part of the 30 meters fixed-radius circle belonging to the forestry land, the center of which is the center of the plot when the center is on the forestry land. The object of assessment is the paths and routes used for recreational use and traces caused from their use, as well as services and structures related to recreational use. The more detailed information is not recorded, but the purpose is that users of the data can search more information from Lipas service.

Size of the observation area

For the calculation, size of forestry land area within a 30-meter observation circle is recorded. If the circle with a radius of 30 m is entirely forestry land (LUC 1–4), the size of the observation area is 28 acres. The size of the plot can be determined using the table below, which shows the size of the plot as a function of the distance between the boundary of land use classes other than 1-4 and the center of the plot, assuming a straight line boundary.

E	No recreational use assessment. The center of the plot is on LUC 1–4, but no recreational use variables have been assessed. Other measurements have not required a site visit, but the site may have a route or structure that is part of the assessment of recreational use.
0	No routes or structures.
28	Size of LUC 1–4 area over 27,5 ares
27	Size of LUC 1–4 area is 26,6–27,5 ares
…	…

Table to determine the size of observation area.

Distance, m	Size, a	Distance, m	Size, a	Distance, m	Size, a
30	28.3	20	25.2	10	20.0
29	28.2	19	24.7	9	19.5
28	28.0	18	24.2	8	18.9
27	27.7	17	23.8	7	18.3
26	27.5	16	23.3	6	17.7
25	27.1	15	22.7	5	17.1
24	26.8	14	22.2	4	16.5
23	26.4	13	21.7	3	15.9
22	26.0	12	21.1	2	15.3
21	25.6	11	20.6	1	14.7

Recreational routes and paths

Recreational use and paths refer to marked or unmarked routes and paths in the forestry land that people use mainly for recreational purposes.

0 No routes or structures in observation area.
1 Marked and / or signposted outdoor route. There is a marked and / or signposted route in the observation area. These include, according to the Sports Venues Database (Lipas), e.g. walking trail, nature trail, hiking trail, cycling trail, horse trail, snowmobile trail or track, trail, fitness track, dog ski trail, canoeing trail and mountain bike trail. It is not necessary to find out the marking / signage from a wider area than the visible part of the plot – if there is no certainty about the route marking, the route is classified as unmarked.
2 Unmarked path. The observation area has a path used by people that is clearly visible in the terrain. Paths in this category may have been originally created by animals or, for example, a forestry machine or a tractor, but have since been used as paths. Trails made and used exclusively by animals are not recorded as recreational routes. If there is also a marked route in the plot, code 1 is used.
3 Forest road, strip road, etc. in the observation area that is also in a recreational use, e.g. an ATV track that does not belong to category 1 or 2. No usage rate is recorded for those belonging to this category.

Lenght of route or path, m

The estimated length of the route / path in the observation area is recorded. The total length of the meandering route is estimated.

Recreational structures and services

Structures and services related to recreational use refer to public or private structures or services in forestry land that people use mainly for recreational activities. If there are several structures or services in the plot, the most significant of them is recorded.

0 No recreational structures and services in observation area
1 Structures or service built for or related to general recreational use. These include, according to the Sports Venues Database (Lipas), e.g. nature tower, sightseeing tower, landscape viewing site or bench, boating service place (place in the terrain / forest related) – e.g. pier, fishing area (place in terrain / forest), camping site, cooking or campfire site, outdoor or ski hut, shelter in wilderness, shed, tipi-like hut or comb, information point or board, beach, cycling area, outdoor fitness area, frisbee golf course.
2 Private camping structure. The class includes, for example, a self-made or occasionally used campfire site, shed or bench.

3 Private boating structure. The category includes, for example, a place for a boat made for one's own use or aplace in the village for common use.
4 Private hunting structure. The category includes, for example, a hunting tower, a game feeding place.

Applicability for classification of laser scanning data LUC 1–B / center point

The purpose of the variable is to describe if the plot may usable for classification of laser scanning data and if the plot clearly differ from the surrounding stand. For example, if a significant proportion of the measured trees are damaged, the tree measurement data does not match the laser scanning view. Further, if the site fertility class at the plot is markedly different from the surrounding stand, the plot is not usable for classification of laser scanning data.

0 Not assessed. No productive forest land or poorly productive forest land on plot.
1 Laser scanning view corresponds the reality.
L The laser scanning view does not correspond to the measured stand, e.g. in seedling, a canopy of a large tree outside the plot extends to the plot, or the plot has trees on secondary stand that have not been measured.
K The site differs greatly from the stand, e.g. the rocky outcrop on plot.
T Severe damage. Plenty of broken, fallen or tilted trees in the plot.

3.5 SEEDLING MEASUREMENTS LUC: 1, Dev.class: 2–3

The number of seedlings for future growing stock and the total number of seedlings are measured if the development class of the dominant story is seedling stand (code 2 or 3). 6–9 seedling measurement points are placed in the stand, less points are needed in even seedlings than in uneven stands.The observation points are placed in a grid with 15 m distance (Figure 4) in a sample point stand. In secondary plots, subjectively selected representative points are selected.

However, in the undivided plot, the first three observation points are located within a fixed-radius circle of 9.00 m at a distance of 6 m from the center point in directions 0, 135 and 225. They replace the observation points in the center of the plot and points both east and west of the center (Figure 4). In a shared plot, the first seedling measurement is always made from the plot area.

The radius of a plot is 2.66 m for measuring the number of seedlings. Thus,
- 9 plots covers an area of 200 m² and each seedling represents 50 seedlings/ha,
- 6 plots covers an area of 133 m² and each seedling represents 75 seedlings/ha,
- 3 plots covers an area of 67 m² and each seedling represents 150 seedlings/ha.

There is a specific data entry sheet on the field computer the seedling recordings and the number of seedlings can be recorded from 3–9 plots. When all measurements are

entered, the software displays the summary data. The team leader uses this data for determining the dominant species and the number of the seedlings.

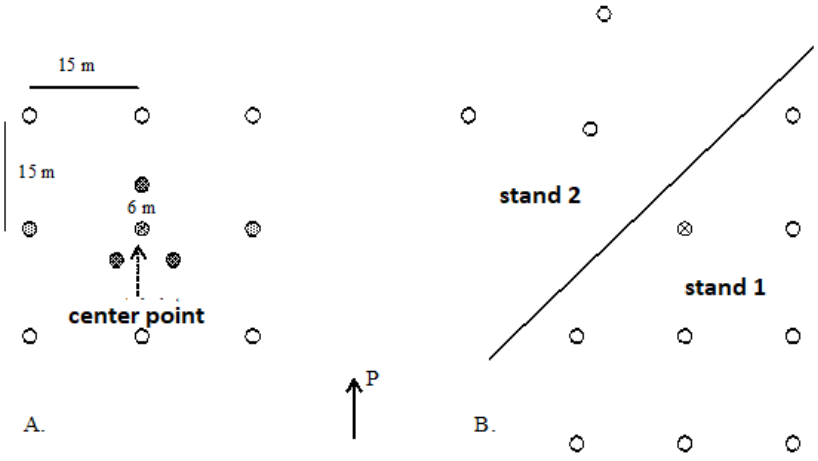


Figure 4 Example of sample point locations in two cases: one stand and two stands.

Crop seedlings : number and mean height, by tree species

The crop seedlings (for future growing stock) consist of "actual crop seedlings" and "complementary seedlings". Distance between counted crop seedlings must be at least 1 meter and the height of each seedling must be at least 50 % of the mean height of the seedling tree storey. In young coniferous seedling stands, the complementary deciduous seedlings must be clearly smaller than the conifers. Deciduous seedlings clearly higher than the conifers are not counted as complementary seedlings for advanced coniferous seedling stands. The mean height and number of seedlings are recorded for each species and for each plot. Number of the crop seedlings cannot exceed 13 on a single sample point. On an individual point, the proportion of complementary seedlings is not limited, unlike when recording to stand record.

Actual crop seedlings are vital, suitable species and have suitable size and position in the seedling stand. These seedlings must also have good technical quality and normally be able to reach log timber dimensions. Accepted broad-leaved seedlings are usually regenerated from seeds or have exceptionally good quality.

The suitable species by site classes are as follows:

1. Pine is suitable for site class 2 and poorer sites and for corresponding peatland forests,
2. Spruce is suitable for site class 3 and more fertile sites and corresponding peatland forests, and spruce mires of site class 4,
3. Betula pendula (birch) is suitable for mineral soils of site class 3 or more fertile,
4. B. pubescens birch is suitable for peat lands and paludified wet mineral soils and soils where the grain size is too thin for pine,

5. Aspen on the best site class 3 stands and more fertile sites on mineral soil. Aspen is not accepted in pine stands.

Other speciesas actual crop seedlings acceptable but more rare species are the following: Acer platanoides, Alnus glutinosa, Oak, Ulmus laevis, Ulmus glabra, Tilia cordata, Fraxinus excelsior and Larix sibirica. Other tree species can be considered economically acceptable, if they - taking into account the site conditions – will produce marketable timber.

Complementary seedlings are seedlings that do not fulfill the requirements set for the actual crop seedlings, but are vital enough to yield marketable timber (as pulp wood) on the site. The seedlings must have status and location such that in the next tending they will be left untouched together with the those seedlings selected for future growing stock. The distance between complementary seedlings and actual crop seedlings must be greater than 1 m.

Pine seedling, of which elk has cut a leader from 3 years or older annual shoot, cannot be considered as a crop seedling immediately after the damage. If some time has passed after the damage and a new leader has started to grow, the seedling can be classified as a crop seedling if the trunk will - in spite of the leader change - in the future yield saw log timber. Such seedling (damaged as described above) can be classified as complementary seedling, if it will yield pulp wood in the future. If so many branches /shoots besides the leader are removed in such a degree that there development of a new leader is doubtful, the seedling is classified at most as a complementary seedling, even if the leader would have broken from a section younger than three years.

This guideline can be applied also for other damages and species. For birch, the part of the stem at the diameter of 2 cm corresponds the previously mentioned third shoot of a pine.

Crop seedlings: tree species

The species of naturally regenerated crop seedlings is recorded by using the tally tree species codes; the species of cultivated seedlings is recorded according to the codes below. All tree species on a seedling plots are recorded separately. Code ‘0’ is recorded, if there is no more tree species (records), so that the data entry program stops requesting new tree species records.

V1 Scots pine	V5 Aspen	V8 Oak
V2 Norway spruce	V6 Larch	VA Other conifer
V3 Birch, *B.pendula*	V7 *Pinus contorta*	VB Other deciduous
V4 Birch, *B.p*ubescens		

Crop seedlings: number

The number of seedlings for future growing stock is recorded separately for every tree species.

Crop seedlings: mean height

The mean height of seedlings for future growing stock is recorded for each tree species.

Crop seedlings: mean diameter

The mean diameter of seedlings for future growing stock is recorded for each tree species.

Number of complementary seedlings

The number of complementary seedlings is entered. It is also included into the total number of crop seedlings(i.e. “actual crop seedlings” and complementary seedlings). Thus, the number of complementary seedlings cannot exceed the total number of crop seedlings, recorded by tree species.

Total number of seedlings

The total number of seedlings is always recorded at least on three observation points. At least one of these seedling measuring points must locate within the circle of 9 m fixed-radius. The total number of seedlings does not include seedlings which - due to their status or size - will have no effect on the growth of the seedling stand or on its future development.

4 TREE MEASUREMENTS

4.1 DEFINITIONS

Ground level: Ground level means the level of the ground at the base of the tree. For more detailed description, see graphs of Annex 4.

Seeding point: The seeding point is usually at the ground level at the center point of the stem cross section. For trees that grow on the top of a stone or old stump, the seeding point is the point where the seeds have started to grow (Annex 4).

Breast height: The breast height is 1.3 m from the ground level, or if the ground level cannot be defined, from the seeding point.

Tree: A tree is at least 1.35 m tall, multi-perennial wooded plant with a distinct stem. Bush formed *Salix* or *Juniper* species are not regarded as trees. *Salix caprea* and *S. pentandra* are the only *Salix* species that may be regarded as trees.

Living tree: Living tree has living branches and the tree is able to continue its growth in the next growing season.

Dead tree: A tree is regarded as dead tree if it has no living branches. Trees that are alive but so badly damaged that cannot grow in the next growing season (e.g. trees felled by storm) are regarded as dead trees.

Commercial dead tree: A dead tree is regarded as commercial dead tree if the wood is still useful at least as fire wood. A tree with a very small diameter or trees broken into several pieces are regarded as commercial dead trees even if the actual use would be difficult to define.

Tally tree: Living or commercial dead tree in an angle-gauge plot.

Old tally tree: On permanent plots: a tally tree measured in the previous inventory as a living or commercial dead tree. **Note:** On permanent plots an old tally tree, which currently is useless dead tree, is regarded as a tally tree even if it does not fulfill the criteria of a tally tree.

Forked tree: A tree is forked, if the forking point is above the breast height. If the forking point is below the breast height, each stem is regarded as an individual tree.

Broken tree: A broken tree may be either a living tree or a dead tree. If more than 50 % of the original volume is in the standing part and this part does not have any living branches, then the tree is regarded as standing dead tree. If the broken part is more than 50 % of the original volume and it has not been harvested, the tree is regarded as fallen dead tree. If the broken part (more than 50 % of the original volume) has been removed, the tree is regarded as a stump and thus not tallied. A broken standing dead tree is regarded either as commercial dead tree or as useless dead tree according to the decaying

stage of the standing part. A broken fallen dead tree is classified accordingly using the lying part of the stem.

Stump: Stump is the remaining part of felling a living tree or standing dead tree. In case of a fallen dead tree a stump is the remaining part when more than 50 % of the volume has been removed (see above). Tree is considered as a stump, even if the broken or fallen part would not have harvested (see also 'broken tree').

Stump height: The stump height is height of the upper most root collar that hinders the cutting from the ground level. If no root collars exist, stump height is 10 cm above the ground level.

4.2 INTRODUCTION

In NFI13, trees are tallied on productive forest land and poorly productive forest land classes. Outside forest land and poorly productive forest land, trees are not measured. Shrubs are not measured.

Trees with a diameter of at least 45 mm are measured as tally trees from a fixed-radius plot. The radius of the plot is now 4.00 meters for trees with a diameter of 45-94 mm, trees with a diameter of at least 95 mm have a radius of 9.00 m, and trees less than 45 mm are measured from relascope plot with a factor of 1.5.

On temporary sample plots on productive forest land and poorly productive forest land and on the new permanent plots, living trees and commercial dead trees are tallied. On old permanent plots, also the non-commercial (non-usable) dead trees are recorded if they in the previous inventory have been measured as living trees or usable dead trees. Bushes are not tallied.

Trees are tallied starting from the compass bearing 0, and the trees are recorded clockwise. The horizontal distance from the plot center is measured to the side of the stem that is facing towards the plot center. The data entry software calculates the maximum distance as the function of the tree diameter and displays it. The horizontal distance from the plot center to the diameter measurement point is measured also in cases of fallen and leaning trees.

In all uncertain cases, i.e. the selection of trees less than 45 mm ind diamater and selection of the trees on boundaries of the fixed-radius plots, must be checked by measuring the diameter of the tree and the distance from the center. The distance of the tree from the center of the plot is measured horizontally to the diameter measurement height and to the side of the stem which is facing the center of the plot. Tree is included if the core of the tree is inside the plot. Data entry program calculates the maximum permitted distance of the tree to the side of the stem and informs this distance. For

relascope trees, the distances are also in Appendix 15: 1 cm / 0.40 m, 2 cm / 0.81 m, 3 cm / 1.21 m, 4 cm / 1.61 m.

The breast height diameter is measured perpendicular to the plot radius. The correct measuring direction must be respected. The breast height stick (1.3 m) must always be used for defining the correct measuring point. The breast height is marked with a permanent drawing pen on the stem. For sample trees, the sample tree number is marked, too. On the permanent plots, the markings must not be too visible and unnecessary removing of epiphytic lichens from the stem and breaking of branches must be avoided. Yet, the epiphytic lichens growing on the stem are not included in the tree diameter.

During the tally tree measurement, the data entry program recognises the NFI sample trees (volume and increment sample trees) on the basis of the sample tree counters, and after all tally tree measurement on the plot, the program reports the required height sample trees, also. Sample tree selection principles are described in Chapter 4.4.

Tally tree and sample tree variables on remeasured permanent plots

The trees measured in the previous inventory must be identified on the permanent plots. Tree map, old tally tree data and the direction and distance of the center point help to identify the trees. The tree map shows also the date of the previous measurement.

The tree data sheets are different for temporary and permanent plots. If any trees were measured in the previous inventory, the previously measured tree data are shown on the display. Tree status is defined for each tally tree. For the stumps of (old) tally trees, the tree status describes whether the stump is from a living tree or from a dead tree. Similarly, the cutting method and time of the cutting are recorded for the stumps. For dead trees that died after the previous measurement, the time of dying is also recorded.

Obvious measurement errors may be detected when remeasuring permanent plots. Errors in the tree species, bearings and distances are the most easiest to detect. If an error is detected, the correct value must be recorded and a descriptive note record is filled in.

The radius of the plot is now 4.00 meters for trees with diameter between 45-94 mm (instead of the previous 5.64 meters). Of the 45-94 mm trees, only those with a maximum distance of 4.20 m are included in the old tally tree data. Trees close to the 4.00 m border are checked as boundary trees. Trees now more than 4.00 m away are recorded using tree type code Y (old checked tally tree) if the diameter is now at least 95 mm. If the distance now measured does not exceed 4.00 m, the tree is measured with tree type code V. Otherwise, the tree is not included in the sample plot and is recorded with tree type code A.

Trees of diameter 45-94 mm in the previous measurement and located at a distance of 4.20–5.64 m are not included in the old tally tree data as old trees. If the diameter of such tree is now at least 95 mm, it is measured as an ordinary new tally tree (tree type U).

It is important that the sample tree numbers match with the previous inventory and are correctly recorded. Therefore, tally trees are identified with the help of the tree map and marked with a drawing pen before starting the tree tally. Tree numbers and tree data are double checked during the measurements.

4.3 TALLY TREE DATA

Tree type **P- ja U-perm.**

Tree status is recorded for the tally trees on the permanent plots. The tree status code describes whether the tree is a remeasured tree or a new tree; the comparison is done against to the most recent inventory. For new tally trees, it is estimated whether the tree has been greater or shorter than 1.3 m in the previous assessment.

V Remeasured tally tree. A tally tree in the current and the most recent assessment.

U New tally tree, height at the time of the previous assessment has been greater than 1,3 m. The reason to include the tree is its increment.

S New tally tree, height at the time of the previous assessment has been less than 1,3 m. The reason to include the tree is its increment.

T New tally tree. Tree is a new tally tree due to a reason other than increment. Such reasons are:
- tree is leaning or has fallen inside the plot
- change in land use class, e.g. afforested land
- tree has been excluded in the previous inventory by mistake
- old sample plot center (sample point) could not identified and plot has been relocated
- tree grows on land use classes 3-B.

K Old tally tree, but now it is a stump, stem is removed. Tree has been identified but removed (more than 50 % of the volume removed).

R Old tally tree, now stump, stem not removed. Tree has been identified but felled, stem is still in the forest (or less than 50 % of the volume removed).

N Old tally tree, measured in the previous inventory by mistake, now a tally tree. The tree is now a tally tree but it is sure that it should not have been measured in the previous inventory. Error has been either in diameter or distance.

Z Old tally tree, not a tally tree now and measured in the previous inventory by mistake as a tally tree. It is sure that the tree was measured as a tally tree in the previous inventory by mistake and yet is not a tally tree now. Error has been either in diameter or distance.

M Old tally tree, land use class changed and the tree does not exist anymore. The land use class change can be either because of a real change (e.g. new agriculture land or constructed land) or because of difference in the classification.

J Old tally tree, land use class changed and tree still exists. The land use class change can be either because of a real change (e.g. forest land has changed to

constructed area, but the tree has not been felled) or because of difference in the classification.

E Old tally tree but tree not found. This code is used only if it is sure that neither the tree nor the stump of the tree exists in the plot.

P Old tally tree but now outside the plot. The tree was included in the previous inventory in the angle-gauge plot, but currently it doesn´t and there is no doubt of the accuracy of the previous measurement. For example, tree has fallen out of the plot.

X An old tally tree that is now out of the plot area. The tree was alive in the previous measurement, but is now a dead tree and does not belong to the plot. The reason is that the tree falls / moves outside the plot.

A An old tally tree that is now out of the plot area. In the previous measurement, tree less than 95 mm that is no longer included in the plot due to diameter and distance or other reason. The checked distance of the tree is more than 4.00 m. The tree has not tilted / moved between measurements (cf. tree types P and X).

If a previously measured tree cannot be found, tree type is E. Check carefully that the tree was not measured as a new tree (T or U).

For tree types Z, M, J, E, P, Z and X and A the rest of the tally tree variables are skipped and the possible sample tree number is converted to 0. For stumps (K and R) tree class, cutting method and time of the cutting are recorded.

Tree number

Trees are measured clockwise beginning from bearing of 0. On the temporary plots and re-established permanent plots (=permanent plots that were not found) the tree numbering is ascending and it starts from 1. On the permanent plots, new (ingrowth) tally trees are not numbered in ascending order. Thus, the numbering of new tally trees is based on their bearing (starting from bearing 0) and the numbering starts from the first free number, which the data entry software gives out. It should be noted that the first free number means all the previous assessments, so for example trees measured as stumps in NFI12 had already reserved a tree number in NFI11, even though the tree does not exist anymore.

Stand number

The number of the stand where the tally tree grows is recorded. The number must match with the stand numbering used in the stand description sheet. The sample point stand gets always the stand number 1.

Bearing

The bearing from the plot center to the mid of the stem at the breast height, using a 360 degree hand compass, is recorded. Sonar measurement scissors automatically registers the direction and distance of the tree. If, for some reason, ordinary measuring scissors have to be used, the direction and distance in the test plots may be omitted.

Distance (cm)

On the permanent plots the distance from the plot center to the stem side facing the plot center, at the breast height. The recoding unit is centimeter.

Species

	A1 *Pinus contorta*	B1 *Salix pentandra*
1 Scots pine	A2 *Pinus sembra*	B2 *Ulmus laevis*
2 Norway spruce	A3 Other pine	B3 *Ulmus glabra*
3 Birch, *Betula pendula cordata*)	A4 Larch	B4 Alm (*Tilia*
4 Birch, *B. pubescens*	A5 Fir	B5 Poplar
5 Aspen	A6 Other spruce or fir species	B6 *Fraxinus excelsior*
6 Grey alder (*Alnus incana*)	A7 *Thuja occidentalis*	B7 Oak
7 Black alder (*A. glutinosa*)	A8 Juniper	B8 *Prunus padus*
8 *Sorbus aucuparia*	A9 *Taxus baccata*	B9 *Acer platanoides*
9 *Salix caprea*	A0 Other conifer	B0 Other deciduous
		C1 *Corylus Avellana*

Diameter (mm)

The stem diameter perpendicular to the plot radius is measured at the breast height. The recording unit is millimeter. On the permanent plots the breast height is defined similarly as in other sample plots, although some markings of the previous assessment are visible.

If the stem is deformed at the breast height, the smallest diameter below the deformation is measured. If a tree is forked below the breast height, each fork is recorded as an individual tree.

The diameter contains bark. If the bark is missing, it is estimated and the value is added into the recorded diameter (also for dead trees).

If a tree was measured as a dead tree in the previous assessment on a permanent plot, the old diameter displayed by the field computer is reused. If the diameter is obviously erroneous, the correct value is recorded. If the tree has died after the previous measurement, the new diameter must be recorded, in spite of the tree class.

Tree class

Tree class classifies trees according to the current or expected timber proportions.

Pine is log timber sized if its diameter at the 4,0 m height (from the stump top level) is at least 15,0 cm. For spruce and other conifers the minimum diameter at the 4,0 m height is 16,0 cm. Deciduous trees are log timber sized when the diameter at the 3,1 m height

(from the stump top level) is at least 18,0 cm. A log timber sized tree belongs to log timber tree classes if it can give at least one saw log which fills the minimum dimensions and minimum quality criteria set for a saw log (Appendix 20).

Living trees

0 *Small tree.* Diameter at the breast height is less than 4,5 cm.

1 *Waste tree.* Diameter is at least 4,5 cm but the stem cannot be used for log timber or pulp wood because of defects (decay, fork, sweep) (Appendix 20.1).

2 *Pulp wood tree*. Diameter at the breast height is at least 4,5 cm but the stem is not log timber sized. Not suitable as log timber because of technical quality.

3 *Saw log tree.* The tree meets the size and quality requirements of the logs (Appendix 20).

Dead trees

A *Usable standing dead tree.*

B *Usable fallen dead tree.*

D *Unusable dead tree*. A tree that was either a living tally tree or usable dead tree in the previous inventory, but that is unusable now.

Stumps (on the permanent plots)

E Stump of a tree that was alive at the time of felling

F Stump of a tree that was dead standing at the time of felling

G Stump of a tree that was dead fallen at the time of felling

Crown class

Tally trees are classified into crown classes according to their current position in the stand (Annex 17). However, if the canopy position of the tree has clearly changed during the last 5 years of the growing season , eg due to felling, the determination of the canopy layer is based on the canopy position to which the tree belonged at the beginning of the growing period. In the development classes 7 and 8 and in uneven aged stands, the classification is based on tree's position at the time when the stand was fully stocked.

Also, single trees in clear cut areas or over-storey trees in development classes 7 and 8 are classified based on tree's position at the time when the stand was fully stocked (crown classes 6/F, 7/G, 5). When a longer time has passed since felling, the canopy layer of old understory trees is recorded again on the basis of the current state of the forest, in which case codes can be for example, 2 or 7 / G, depending on the recovery of the tree and the stand.

If the stand consists of young conifers and deciduous trees that are of the same age but clearly higher than the conifers, the conifers and deciduous trees are classified independently. The crown class of retention trees is recorded using alphabetic codes.

In the plot there might be individual trees of different storeys even though these classes were not separated in the stand description sheet. Therefore, in addition to the allowed storey records (in the stand descriptions) single tree strata may exist, for instance there might be an over-storey tree in an advanced thinning stand.

Rules given in this manual for classification of tree storeys are applicable also for grouping of trees into crown classes. Trees with clearly different growth rates (i.e. increment percents) cannot be classified into the same tree storey.

2, B Dominant or co-dominant tree in the dominant tree storey
3, C Intermediate tree in the dominant tree storey
4, D Suppressed tree in the dominant tree storey
5, E Under-storey tree
6, F Dominant or co-dominant tree in the over-storey
7, G Intermediate or suppressed tree in the over-storey

Cutting method **P- and U-perm.**

On the permanent plots the stumps are classified according to the cutting methods. If the latest cutting described in the stand descriptions has created the stump, code K is used. If no cutting is described in the stand description or if the tree was felled in a different cutting, codes 0-A, E, P or S are used.

Code 0 is used if the tree was felled in a cutting that covered only part of the stand (removal of a single tree) or in a case of pre-harvest clearing. There may be more than just one cutting method for stumps in a plot (or on a part of a plot).

Cutting method descriptions are the same that are used in the stand descriptions (in accomplished cuttings). More detailed description of the cutting methods is presented at the stand level variable description.

K Cutting method described in the stand descriptions as the latest cutting
0 Removal of a single tree or a pre-harvest clearing
1 Thinning or clearing of a seedling stand
2 Tending, spot cleaning method
3 First thinning
4 Other thinning
5 Thinning before regeneration cutting
6 Removal of over-storey trees
7 Clear cutting for cultivation
8 Regeneration cutting for natural regeneration
9 Shelter tree cutting
A Special cutting
E Selective cutting in uneven aged forest
P Gap cutting
S Tree removal on unproductive drained peatlands

Time of cutting (for stumps) **P- and U-perm.**

The time is recorded as number of cutting seasons from the cutting. A cutting season starts on the 1st of July (which is regarded also as the starting point of the field season of assessments). If the cutting method is marked as K, the time of cutting is not recorded. One plot (or part plot) may have multiple stumps with different cutting times.

- Time of felling is the same as in the stand descriptions
0 Ongoing inventory field season
1 Previous cutting season
2 Two cutting seasons ago
3 Three cutting seasons ago
4 Four cutting seasons ago
5 Five cutting seasons ago
6 6–10 cutting seasons ago
A 11–30 cutting seasons ago

Time of dying **P- and U-perm.**

Old tally trees that have died after the previous measurement the time of dying is recorded as the number of cutting seasons. The time is recorded for both usable and non-usable dead trees.

– Dead tree already in the previous measurement
0 Ongoing inventory field season
1 Previous cutting season
2 Two cutting seasons ago
3 Three cutting seasons ago
4 Four cutting seasons ago
5 Five cutting seasons ago
6 6–10 cutting seasons ago
A 11–30 cutting seasons ago

4.4 SAMPLE TREE DATA

Volume, growth and height sample trees are measured in NFI. Based on the volume and growth sample trees, the volume and proportions of timber classes and the growth of the stand on the basis of temporary plots are calculated for the tally trees. Height sample trees are measured for the height estimates needed in laser and multi-source analysis. The sampling of height sample trees is done based on the number of trees measured from the plot.

Volume and growth sample tree sampling is carried out on tally trees at regular intervals when the sum of the basal area represented by the trees (m2 / ha), taking into account the radius of the test area, exceeds the sampling interval of the sample tree sampling. Summation is done over clusters and plots, for living and dead trees separately. A tree of at least 45 mm diameter is selected as a sample tree when the basal area exceeds 15 m2 / ha in southern Finland and 10 m2 / ha in northern Finland. Of the trees less than 45 mm selected with a relascope, every tenth living tally tree in southern Finland and every seventh living tally tree in northern Finland is a sample tree. In the same way, every tenth / seventh dead tally tree is a natural loss sample tree. The field computer informs whether the current tree is a sample tree and it also shows the sample tree number on the plot. On remeasured permanent plots, also old sample trees are always sampled.

Sample trees are not bored on the permanent plots, and age of the trees is estimated by counting the branch whorls or by boring a tree growing outside the plot in the same stand. Other growth variables, e.g. thickness of the bark, growth of the diameter or height, are not measured on the permanent plots.

From dead sample trees the upper diameter, height/length and damages are recorded. Useless dead trees are not regarded as sample trees.

The height sample trees are selected on a plot-by-plot basis from live trees with a diameter of at least 45 mm in the dominant storey and the over-storey of the fixed-radius center point stand. The median tree of every storey and species is selected for as the height sample tree. If there are at least eight trees / tree species in the storey, tree representing the upper quartile is also measured as a height sample tree.

The selection of height sample trees is made as a separate procedure after the tally tree measurements, in which case the data entry program declares suitable tally trees as height sample trees. The height sample tree marking is recorded for the tally tree selected - the median tree ‘M’ and the upper quartile tree ‘Y’.

Height sample trees are used for local calibration of height models, so their height-to-diameter ratio should be normal for the plot. The data entry program proposes a NFI normal sample tree as the height sample tree if its diameter is the required diameter ± 20%. It is important that the diameter and height are measured from the same tree. If, for example, the tree proposed by the data entry program is damaged, and other trees in the same stratum have been measured in the plot, the tree must be replaced with another tree with the nearest diameter. If the height sample tree cannot be replaced (e.g. the only

tree), the damaged tree must be measured. If the tree is broken, the broken part is recorded as with NFI's own sample trees.

For median trees, height and age are measured, for upper quartile trees, only height is measured. The age of the median sample tree of the dominant tree species is calculated from either an extracted core sample or branches. For other tree species, age can be estimated using this. For a non-median sample tree, ‘E’ is stored for age.

Seeding method

0 No accurate information
1 Naturally from seed regenerated
2 Naturally from sprout regenerated
3 Planted
4 Seeded

If a planted tree cannot be for surely recorded whether it was seeded or planted, it is considered as planted.

Thickness of bark (mm) Temp.plot

The thickness of the bark is measured perpendicular to the plot radius at the breast height from both sides of the tree. The sum of the measurements is recorded in millimeters. The thickness of the bark is measured only on the temporary plots.

Lowest dry branch (dm)

Dead branch, decayed branch stub, knothole and knot lump which is least 15 mm of diameter is considered as a dry branch. This variable should particularly indicate the limit for dry branches which will have an effect on sawing yield, rather than the height of the lowest dead branch (even though in many cases these are the same). Thus, a single dry branch in a branchless stem does not necessarily cause recording (Fig. 5).

The lowest dry branch is recorded only for pine, spruce, birch, aspen and other tree species belonging to tree class 7. For other tree classes and species this code is recorded as “-“. If the lowest dry branch does not exist or if it is located upper than the lower limit of the living crown, the code ”E” is used. The recording unit is dm.

Height to theof living crown (dm)

Height from ground to the lower limit limit of the living crown is measured from all living trees and the recording unit is dm. Living branches separated by two or more dead branch whorls are not counted in when measuring the lowest limit for living crown (Fig. 5).

Height

Height of a tree is measured from the ground level to the top of the tree (Annex 18) and the recording unit is dm. If the seeding point of the tree is higher than the ground level (e.g. trees on the top of a stone, Annex 4), the height is recorded at the seeding point. If the top of a tree is dried or got broken, it needs to be observed whether the tree has formed a new leader. If the tree has formed a new leader, the new leader defines the top of the tree. If no leader change has occurred, the height is recorded up to the top of the standing part. Height is recorded also for dead standing trees.

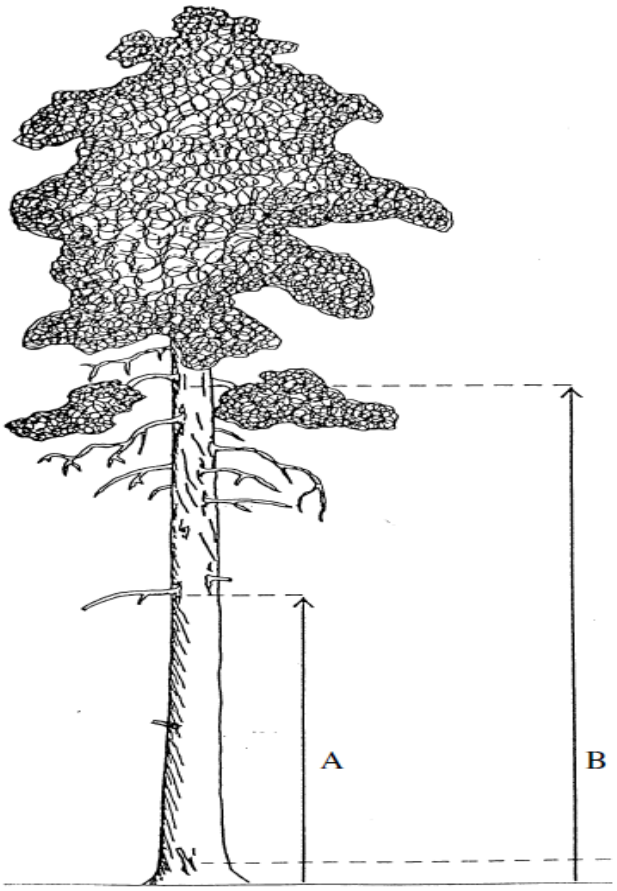


Figure 5. The lowest living branch and the lowest dry branch.

The length of the broken part (dm)

The length of the broken part is recorded for two cases: 1) for a tree, and 2) for forked main stem which leader has got broken and no leader change has occurred. If for some reason the broken part cannot be measured, the length is always estimated. The recording unit is dm.

The length of the broken part is also recorded for dead trees, if applicable. The recording is not done for broken dead trees whose (commercial) broken part lies on the ground. For these trees, the length of the broken part is added to tree height and the sum is recorded as the (total) height of the tree.

Increment data **Temp. plots**

The period for increment measurement is the five full growing seasons prior to the measurement. If the measurement day is before 1st of August, the cumulative growth occurred during five growing seasons prior to the current season are used. From 1st of August forward the period consistings of the current year and four previous years is used.

Height increment during the last 5 years (dm)

Conifers: Cumulative height increment during the past 5 years (increment measuring period) is recorded. The recording unit is dm. Cumulative height increment is usually measured using a Vertex device and binoculars equipped with a measurement scale. The collected data are converted by the program (in the field computer) into the height increment (dm). If a SUUNTO hypsometer is used for the measurement, the observations are converted into the height increment with the help of tables presented in Appendix 19. Note that there are two different types of binoculars for height increment measuring and their scales are different: both of them have their own incrementcalculation formulas in the data entry software, and tables are presented in Appendix 19. For small sample trees the height increment can be measured with a pole or Vertex directly. Direct measurement with Vertex is allowed only for rather short and well-growing sample trees, and in these cases the top of the tree has to be fully and clearly visible.

If the top of the tree has got broken, height increment is always recorded with the code E. If a tree with dry top has certainly gained some height increment during the increment measuring period in questoin then this increment is recorded as the height increment. In other cases, height increment of trees with dry top are recorded with the code 0.

Deciduous trees: For deciduous trees - with a living crown - a growth space code is recorded, and this code explains mostly the crown class of the tree without separating tree storeys. The information is used in the height increment calculation of the deciduous trees, so the crown classes must be studied more detailed than for the whole stand. The growth space is essential in defining the crown class, meaning that it must be assessed whether the tree has grown freely during the last 5 years or whether its growing space has been limited. In cases of broken deciduous trees or trees with dry tops, the height growth is always recorded with the code E.

A Dominant tree
B Co-dominant tree
C Intermediate tree
D Suppressed tree
E Broken / dead top

In addition to the growing space, the height growth code is estimated (dm) for deciduous trees, if the tree is less that 81 dm tall. The data are recorded to the data entry field "height increment of the inventory summer".

Height increment of the inventory summer (dm)

Height increment of the inventory summer is measured for living conifers and the recording unit is dm. Until the end of July, these data mean uncompleted increment, and this measurement is not included in the cumulative height increment during the last 5 years. Height increment of the inventory summer is recorded also after 1.August, even though this measurement is included into the 5 years' cumulative increment.

Diameter increment (mm)

An increment core is bored from living sample trees on the temporary plots. These cores are used for determining the tree age and cumulative diameter (5-year) increment. If the core does not reach the pith (e.g. because of decay), the diameter increment (= 2 x "5-year radius increment") has to be measured in the field. Trees, which are younger than 5 years at the breast height, are not bored, and the diameter increment is not recorded in the field. The recording unit is mm.

The sample tree is bored perpendicular to the radius of the plot at the breast height, and from the right side of the tree when looking from the center of the plot. A core up to the pith of the tree is bored and the cores are placed in specific plastic specimen holders and sent to the laboratory. The samples and specimen holders are marked as follows:

- A core is marked - right after the bark - with plot and sample tree numbers: For example, the sample tree number 1 from the plot 8 is marked as '8–1'. If the bark and phloem comes off, the end of the core is marked with X to address that the core has not got broken.
- Sticker on the plastic specimen holder is set under the first core and it is marked with the following data: sampling stratum, inventory region, code of the team leader, date of the boring and indecces of the cluster. A specimen holder can include cores from several clusters, in these cases the change of the cluster number must be clearly marked with a sticker. Also the possible change in the boring date has to be marked with a sticker.

Age measurements

Age at the breast height (year)

Age of the sample trees is usually not defined in the field, since the core is sent to the laboratory. If the core gets broken, the age is defined from the core or by counting the branch whorls (Figure 6) or by recording the missing part of the core. The year of the inventory is included in the age. The age is recorded in two phases: First, variable IKAILM is recorded.

This describes the measuring method of the age. The data entry software offers four alternatives:
1) code A means that age is calculated/estimated and recorded in the field. If measurable core cannot be taken (e.g. the tree diameter is less than 1 cm) then code A is applied.
2) B means that the years missing from the core are recorded. This is the default and the most common method.
Codes C and D are used, if the core is not complete because of e.g. decay,
3) code C means that the missing part from the core are recorded in years, and
4) code D means that the missing part from the core are recorded in centimeters.

The main method to record the missing part of a core is method C. Missing years or centimeters are recorded as into the variable D1.3-IKA in the software.

On the permanent plots, trees are not bored, but the age is estimated by counting the branch whorls or from bored tree (which was bored for estimating the age of the stand).

A Age is calculated /estimated in the field
B Age is measured indoors from a core
C Years missing from the core are recorded
D Centimeters missing from the core are recorded

If the core missed the stem pith, missing years are not recorded in the field.

Age when the breast height was reached (year)

Age when the breast height was reached is recorded similarly for the sample trees as for the stand. If this age is not taken from tables, the estimated age is recorded (in years).

a = age at the breast height
b = age when the breast height was reached

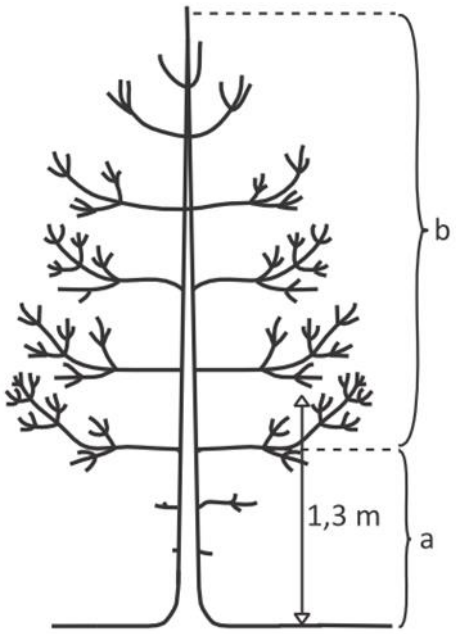


Figure 6. Defining the age of a tree.

Age when the breast height was reached is always recorded for planted and coppice trees. Possible ancillary information about the timing of the planting, or the number of branch whorls below the breast height is used for help in this assessment. When defining this age it should be taken into account that the counting of the age starts from the germination phase of a seed (excluding coppices), so the time of the initial phase growth has to be added to the number of branch whorls. At those sites where the taxation class is not the same as it was during the seedling phase of the tree, the age which corresponds the age at the seedling phase is recorded.

The age entered to the field computer either in years or by selecting a letter code N, or A–E (taxation class). If we use the letter codes, the age (incremental) is defined from the tables the help of the current taxation class (N) or another taxation class.

N Age (incremental) according to the stand's current taxation class
A Age according to taxation class IA
B Age according to taxation class IB
C Age according to taxation class II
D Age according to taxation class III-IV
E Age according to poorly productive forest land or wasteland.

Damage observations

Recorded damage variables for sample trees are as follows: damage type, age of the damage, causing agent, and degree of the damage. Coding principles are the same for

damage type, age of the damage and causing agent as on the stand descriptions sheet. The most significant damage (affecting on the vitality and timber quality of the tree) is recorded as damage type and causing agent. Nevertheless, degree of damage is the combined effect of all damages.

Damage type

0 *No damage* in the sample tree

1 *Standing dead tree*. There are no living branches in the tree or the tree is will die before the next growing season.

2 *Fallen or broken tree*. Tree is fallen or broken below the mid-point of its living crown. The tree can be alive or a dead tree. In addition, trees leaning badly are regarded as fallen trees.

3 *Decayed tree*. On deciduous trees hard heart wood rot which has no effect on log timber yield, is not recorded.

4 *Damages on the stem*. Damage that is either on the stem or on the roots, no further than 1 meter from the stem. The damage agent can be e.g. fungi, frost, browsing.

5 *Flows of resin*. Abnormal flow of resin observed along the stem higher than 1,5 m from the stump level (flow lower than this level are recorded with the code 4). The length of the visible flow must be at least 30 cm.

Dead or broken leader

61 *The leader of the stem has got broken*. The leader has got broken above the upper half of the living crown and the tree has not developed a new leader.

62 *The leader of the tree is dead*. The leader of the tree and usually the upper shoots are dead in the upper half of the crown and the tree has not developed a new leader.

Leader die-back, multiple leaders or deformed leader. Damages at the top that have not yet developed into damages on the stem.

71 *Leader change* caused by leader damage, which has not yet developed to damage in the stem.

72 *Multiple leaders*, bush formation in the top. Occurs especially among seedlings and young trees, caused e.g. by growth disorder. Flat top of old pines is not considered as damage, unless it is caused by some external factor.

73 *Bent top*. The leader or the top formed during the past years is strongly bent, curved or drooped.

8 Deformed stem. Sweeps or forks in the stem, caused e.g. by former die-back or poor quality planting.

Branch damages

91 Dead branches within the living crown. The tree has an abnormal amount of dead branches caused e.g. by drought or insects. Dead branches of old trees, which have died long time ago and lost their lateral branches are not counted.

92 Broken branches within the living crown. The tree has an abnormal amount of broken branches caused e.g. by snow or elk.

93 Deformed or bent branches within the living crown. The tree has an abnormal number of deformed, bent or curved branches caused e.g. by some external factor, e.g. snow or pine twisting rust within the living crown.

A Abnormal dying of branches in the lowest part of the crown, typically caused by fungi. The normal competition of neighboring trees is not recorded as damage.

Loss of needles/leaves or shoots. Destroyed (fallen) needles, leaves or shoots. Falling of needles or leaves caused by normal annual growth cycle or male flowering is not recorded as a damage.

B1 Needles/ leaves/ shoots of current growth season
B2 Older needles
B3 Needles of all ages
B4 Loss of leaves

Discolored needles or leaves. Color differs from healthy and normal. Color differences that are caused by the annual growth cycle are not considered as damages.

C1 Needles of the ongoing growth period.
C2 Older needles
C3 Needles of all ages
C4 Discolored leaves
D Deformed needles or leaves. The needles or leaves are abnormal in size or form, e.g. curly or rolled.

Timing of the damage

The timing of the damage describes when the damage started and whether it continues.

- No damages
0 Damage started less than 2 years ago. The damage has emerged during the year of the field measurements or during the previous year.
1 Damage started 2–5 years ago, and still continues. The damage is regarded to continue if the causing agent still affects on the growing stock, or the trees have not started to recover.
2 Damage started 2–5 years ago, but passed. The damage has passed if the causing agent does no longer affect on the growing stock and the trees have started to recover, or if the damage has already killed the trees.
3 Damage started more than 5 years ago, and still continues.
4 Damage started more than 5 years ago, and it is passed.

Causing agent

Human intervention is recorded as the causing agent only if the damage has not been caused by purpose. Thus, clearing of bushes (mechanically or chemically) is not recorded as damage.

E No damages
0 Not identified

A Abiotic factors

A1 Wind

A2 Snow
A3 Frost
A4 Other climatic factors
A5 Fire
A6 Soil factors (other than AA, AB and AC)
AA Drought
AB Unbalance of nutrients
AC Wetness, flood. Flood damage caused by a beaver is recorded as B3 and damage caused by mire restoration is recorded as A9.
A7 Harvesting
A8 Air pollution (primary agent of the pollution must be identified, e.g. industry, traffic, agriculture)
A9 Other abiotic or human intervention
A0 Unidentified abiotic factor.

B Animals

B1 *Cricetid* rodents
B2 Elk
BC Other *Cervidae*
B3 Other vertebrate (beaver, hare etc.)
B4 Bark beetles
B5 Pine weevil
B6 Pine sawfly
BA *Diprion pini*
BB *Neodiprion sertifer*
B7 Other needle-damaging insect
B8 Spruce bark beetle
B9 Other identified insect
B0 Not identified insect

C Fungi

C1 *Annosum* root rot (pine: *Heterobasidion annosum*, spruce; *Heterobasidion parviporum*).
C2 Other rot fungus (e.g. *Phellinus pini, Inonotus obliquus, Fomitopsis pinicola*)
C3 *Scleroderris* canker
C4 Pine twisting rust
C5 Blister rust
CA *Chrysomyxa ledi* needle rust
CB Birch rust
C6 Other rust fungus
C7 Pine needle-cast fungus
CC *Lophodermella* needle cast
C9 Other identified fungus
C0 Unidentified fungus

D Other

D1 Competition. Shadowing or whipping effect caused by neighboring trees or undergrowth. However, over-density nor high basal area of the growing stock are not regarded as a damages.

Degree of the damage

– No damage
0 Damage can be observed, but it does not decrease the vitality or log timber acquisition.
1 Damage does not decrease vitality of the tree, but it reduces log timber acquisition.
2 Damage decreases the vitality slightly, but does not affect log timber acquisition. Damage is usually temporary and it can slow down the growth.
3 Damage decreases the vitality slightly and reduces affect to log timber acquisition.
4 Damage decreases the vitality significantly, but does not affect to log timber acquisition.
5 Damage decreases the vitality significantly and reduces log timber acquisition.
6 Lethal or the tree is already dead.

Tree class change for sample trees

When the additional variables are recorded for sample trees, it is possible that the original tree class defined while measuring the tree as a tally tree is found erroneous. If the tree class is changed as a consequence of these additional observations, the changed tree class is recorded as a separate variable - it is not allowed to change the original tree class. Data entry software gives a default value (i.e. the value recorded in tally tree data reading) which is accepted if the tree class remains the same, or a new value is given if it is changed.

If the tree class of a sample tree is changed, other sample tree measurements (e.g. the lowest dry branch) must be completed to correspond with the new tree class. Trees class given as the tally tree data must not be changed.

Bucking

Bucking (division of stem to quality parts) must be done for sample trees of tree classes 7 (log trees) and those sample trees of tree class 3, whose stem is partly non-suitable for pulp wood because of its poor quality.

The stems are divided into quality parts, starting from the stump height. Saw timber classes are as follows: branchless or thin-branched base part (so called quality base) and parts with dry or living branches. Parts, which are not suitable for saw timbers are separated to separate classes. The enforced cutting points are described as a separate class. The criteria set for log timber and pulp wood classes are presented in Annex 20.

Quality part indicates a continuous part of the stem that is of the same quality class and that does not include any enforced cutting points. From quality parts class trees, length and reason for decreased quality (excl. class 1) are recorded. For enforced cutting points, the reason for cutting is recorded.

Quality parts do not usually have requirements in terms of their length. However, quality parts (of logs with Quality code 1–2) shorter than the minimum log length are not separated, if the parts under and above it do not fall into one of following classes: lower quality class, enforced cutting point or a stump.

The sequential saw timber class parts should together fulfill the minimum length set for a log. Thus, a too short saw timber part between non-timber quality parts is never separated as a saw timber quality, if its length is less than 31 dm (pine and deciduous) or 41 dm (spruce).

In pulp wood stem bucking, the waste wood is separated from other part of stem according to standard quality, length and cause reasons codes. As a default, the data entry software does not ask for bucking data for sample trees of pulp wood tree class, so the possible bucking data entry can be done only by returning back to the bucking data in the software.

Quality

The quality parts and enforced cutting points for the bucked stems are recorded as it follows:
1 Branchless or thin-branched base part
2 Base part with living or dry branches
4 Buttress part, or a part of the stem that does not fill criteria set for commercial timber (suitable for pulp wood)
5 Intermediate reduction ("välivähennys") (only for deciduous trees, suitable for pulp wood)
6 Waste wood part (does not qualify even as a pulp wood)
7 Saw timber part of a forked tree (forked part)
8 Enforced cutting point inside a saw timber part

Length of the quality part (dm)

The length of the parts is recorded in dm. For forked trees, the volume of logs from forked part is calculated in tens of liters (Annex 21) and the volume is recorded as one log part. When the quality code is 8 (i.e. enforced cutting point), the length is not recorded (=0). When the last recorded part continues until its minimum diameter, the length of the part is not recorded and the code is E.

Reason for decreased quality or necessary cutting

The reason for decreased quality or enforced cutting is recorded.
0 The quality of the part is 1 or 7
1 Living branch, branchy

2 Dry, decayed or standing branch, branch lump or hole
3 Sweep(s)
4 Long sweeps
5 Fork
6 Decay
7 Scar, damages on the stem
9 Other defect

5 DEAD WOOD

Dead wood as a habitat is important for many species. Each standing dead tree or part of it and fallen dead trees are recorded to the dead wood data sheet. In addition, tallied commercial (useful) dead trees are recorded. Measurements for dead trees are carried out only on productive forest land and poorly productive forest land. Dead trees are measured in the sample point stand using a circular sample plot (with the radius of 7 m).

The dead trees were mapped in the previous measurement, and now we are trying to get more detailed information about the change in decaying trees. The trees must now be identified with the help of a dead tree list on the tree map and data entry device with the directions and distances of trees from the center. For dead trees, a new variable 'dead tree type' is now defined, just like the tree type of tally trees.

If the land use class of a stand that has previously been productive forest or poorly productive forest land has changed to class 3 – B, the old dead trees are set off with dead tree type P.

Standing dead trees are trees or parts of trees, which are standing in more vertical position than 45 degrees from the ground level. The seeding point of a tree determines whether the tree falls into a sample point plot, meaning that for fallen trees the location of the stump is crucial. If a stump of a broken tree cannot be found, the location of the base determines whether the tree falls into the sample point plot. Standing dead tree is measured if its diameter of breast height is greater than or equal to 100 mm, and its length is at least 1.3 m.

Other dead trees or parts of them are measured as fallen dead trees. The diameter 1.3 m away from the base has to be at least 100 mm and the length at least 1.3 m. From fallen dead trees only the part inside the plot of 7 m radius is recorded on the sample point stand; this recorded dead wood particle should be at least 100 mm thick. If the point where the thickness permanently lowers below 100 mm is difficult to locate, e.g. because of the ground vegetation, the measurement can be extended up to any even centimeter class. If the tree lay crossing the border of the sample point stand or the circular plot, the length of the particle inside of the borders is recorded. Fallen dead trees are measured even if the length of the particle lying in the sample point plot is less than 1,3 m and if this particle otherwise fulfils the criteria set for diameter and length.

Estimated variables for both standing and fallen dead trees are the following: dead tree type, stem number, tree species, outward appearance, bark coverage and degree of decay. The degree of decay grading is similar both for standing and fallen dead trees, although the class 5 is not applicable for standing dead trees. Outward appearance of the tree, bark coverage and degree of decay are estimated from at least 100 mm thick part of the stem.

The breast height diameter is measured for standing dead trees, and the length is measured for broken standing trees whose diameter at the top is at least 100 mm. The variables measured for fallen dead trees are the base and top diameters and the length of the part inside the sample point plot. In addition, the tree class is estimated for fallen dead trees.

Diameters of both standing and fallen dead trees are recorded as such regardless whether the tree has any bark.

If a tree is broken and its standing part is alive (with live branches), the standing part is not measured as a dead tree, but its broken (fallen) part is recorded as a dead tree. If a standing tree has got broken under the breast height, thestump part is included i when defining the height of the standing part and the the breast height is located taking the stump height into account. If a tree is broken below the breast height and that tree is a fallen dead tree (< 45 degrees), the stump part is not taken into account when measuring the lying tree.

If a fallen dead tree consists of several pieces, the cumulative length is recorded and all other variables are also recorded just for one observation. If a fallen dead tree contains fully decayed parts which do not differ from the ground, these parts are not counted as fallen dead tree. Trees fallen as the result of human activity and which have no specific permanent function are recorded as fallen dead trees; for example, stems thrown over a ditch or some other moist spot located outside permanent routes, and trees left over (or in) the ditches or on the ground after the harvesting are regarded as fallen dead trees, and thus these are recorded. On the contrary, logs waiting for transportation is not measured. In addition, bridges, footbridges and other trees dedicated for permanent use are not recorded as fallen dead trees.

Measurements of dead trees must be performed in a way that the trees are not damaged and they will remain measurable in the next inventory round.

Plot number

Plot numbering corresponds with the numbering on the stand data.

Dead tree type

The dead tree type is used to sort new dead trees, re-measured old dead trees, and non-measurable old dead trees.

New dead trees

- U New dead tree in an old permanent plot. Tree has died the after previous inventory or fallen to the plot from outside of the plot. Dead trees that have not been measured by mistake on the previous inventory are included in this type class.
- T New dead tree in a new or re-established old permanen plot. Trees that were not included in the plot in previous inventory, but are now part of the plot, are included in this type class.

Old dead trees to be remeasured

- V Old dead tree. Dead tree measured in previous inventory, but possibly has changes, e.g. only part of the dead tree left or a standing dead tree is now fallen.
- W New part of old dead tree. E.g. part of standing dead tree, when standing part is still measured or a part of broken fallen dead tree that is measured separately.

Non-measurable old dead trees

E Dead tree not found, even though the plot center point is found.
M Decomposed tree. Measured in previous inventory, now decomposed to a non-measurable state or it does not meet the size requirements anymore.
R Broken. Measured in previous inventory, now broken e.g. during forest management and does not meet the size requirements anymore.
P Removed / other reason. The reason for removal may be a change in sampling or a change in land use class, a change in the stand of the dead tree to a secondary stand, or re-establishment of the plot. The reason may also be the removal of an individual dead tree from the plot, e.g. due to felling. The category also includes dead trees mistakenly measured in the previous measurement, e.g. from a secondary stand.
K Harvested. Old dead tree harvested, usually a stump is remaining.

Numbering of dead tree

The measurement order of dead trees is free. For new dead trees, the data entry program suggests the first free number.

Tree Species

0 Not identified	8 *Sorbus aucuparia*
1 Pine	9 *Salix caprea*
2 Spruce	A0 Unidentified conifer
3 Silver birch (*B. pendula*)	A1 Other conifer
4 *B.pubescens* birch	B0 Unidentified deciduous tree
5 Aspen	B1 Other deciduous tree
6 *Alnus incana*	B2 Unidentified birch
7 *Alnus glutinosa*	

Dead tree class

P Standing dead tree
M Fallen dead tree

Distance (cm)

The horizontal distance is measured from the center of the plot to the side of the stem facing plot center at breast height (with standing trees) or to the point of measuring base diameter (lying dead trees).

Bearing

The direction is recorded with a 360-degree hand compass from the center of the plot to the stem midpoint at breast height (standing trees) or to the the point of measuring the base diameter (lying dead trees). If there are several dead trees that are described in one record

(e.g. abandoned pile of logs), the bearing and distance from the center of the plot to the nearest point of the pile are recorded.

Diameter at breast height (cm) standing dead tree

Diameter is measured at the breast height of a standing tree.

Diameter at the base of the tree (cm) fallen dead tree

In the case of fallen dead tree with roots exposed, the diameter is measured from the height of the stump or from the point where the bottom part (center line) of the fallen tree intersects the boundary of the sample plot for dead trees.

Diameter at top end of the tree (cm) fallen dead tree

The diameter at the top end of fallen dead tree at 1 cm accuracy.

Height (dm)

The height of the standing part (dm) is measured up from the seeding point of the tree. The height is recorded if the top diameter of the standing part is at least 100 mm. The height is recorded in dm, even though the precision of 0,5 m is sufficient for longer trees. If the top diameter of a standing tree is less than 100 mm, code T is recorded.
For fallen dead trees it is recorded (dm) the distance between the base and top diameter measuring points. For a tree fallen with roots, the lower measurement point is the stump height.

Appearance of the tree

0 No information (fallen dead tree, mostly decayed)
1 Dead standing, under 1/3 of the top is broken
2 Dead and rotting tree of a tall natural stump, over 1/3 is broken
3 Fallen dead tree, which has fallen with together roots
4 Broken tree
5 Manmade stump or dead and rotting tree
6 Jump butt or log that has been left in the forest
7 Manmade top part (e.g. harvest residue)

Coverage of the bark

Coverage of the bark from the stem surface is estimated in 20 % classes. For fallen dead trees, also the part lying against the ground is estimated, if possible.

0 Not estimated, fully covered by epiphytes.
1 0–20 %
2 21–40 %
3 41–60 %
4 61–80 %
5 81–100 %

Fallen dead tree classes

The variable separates airborne and dead trees cut in several pieces.

0 Mainly off the ground
1 Mainly on the ground, but dried after dying like an airborne tree
2 Mainly on the ground
3 On the ground in many pieces so that the felling direction or the total length of the parts are difficult to determine

Number of objects on a plot (represented by one recording) (if >1)

If the sample point plot has so many dead trees that measuring all of them would take too long (e.g. there is a stack of forgotten logs), the median size stem can be selected and the count of logs and other variables are recorded. When measuring a single tree, this field is left blank.

Degree of decay

Degree of decay is estimated as the average hardness of the stem, although one stem usually has differently decayed parts. A knife is used for help and it is pressed with a moderate force along different parts of the stem. Other observations (see characteristics described below) are important in the determination of the decay class, also, and parts of a tree above 2 m height are estimated without using the knife test.

Standing dead trees

1 Hard timber. Knife goes into the log/stem only few millimeters. Typical characteristics: Usually the bark has not yet loosened remarkably and the branches have not fallen down. This class contains also hard deadwoods which have not yet started to decay.
2 Rather hard timber. The knife goes into the log/stem 1–2 cm. Typical characteristics: The branches have started to fall down and the bark of conifers has started to get loose. The upper part of deciduous trees has often many fruit bodies of shelf fungus.
3 Rather soft timber. The knife goes into the log/stem 3–5 cm. Typical characteristics: Conifers have lost their bark from other parts than from the base. Deciduous trees usually have still bark, but the stem has started to decay. The branches have mainly fallen down and only the bigger branch parts are left. Part of the top has usually fallen down.
4 Soft stem. The knife goes easily into the log/stem up to the handle. Typical characteristics: The stem remains in one piece only because of the bark. All branches of deciduous trees have usually fallen down. The stem is usually broken, only the butt pat of the dead and decaying tree may still stand.

Fallen dead trees

1 Hard timber. Knife goes into the log/stem only few millimeters. Typical characteristics: Unpeeled, recently fallen stem. Possible epiphytes are of species that grow on standing trees (e.g. Hypogymnia physodes). This class includes also hard timber trees which have dried while standing and then fallen, and which have not started to decay yet.
2 Rather hard timber. The knife goes into the log/stem 1-2 cm. Typical characteristics: Tree usually still has bark. Epiphytes are sparsely, mainly of species of standing trees.
3 Rather soft timber. The knife goes into the loog/stem 3–5 cm. Typical characteristics: The bark has usually got broken and loosened widely. Locally plenty of epiphytes, but not as a large population. This class often contains e.g. a pine, which has greatly decayed sapwood but hard heartwood.
4 Soft decayed stem. The knife goes easily into the log/stem up to the handle. Typical characteristics: the stem is often with no bark and it is covered by epiphytes. Large populations of lichens and mosses exist.
5 Very soft, and degrades with bare fingers. Typical characteristics: Usually fully covered by epiphytes. Epiphytes mainly of mosses of the ground layer, e.g. Pleurozium schreberi and Hylocomium splendens and Cladonia lichens.

APPENDIXES

LIST OF APPENDIXES

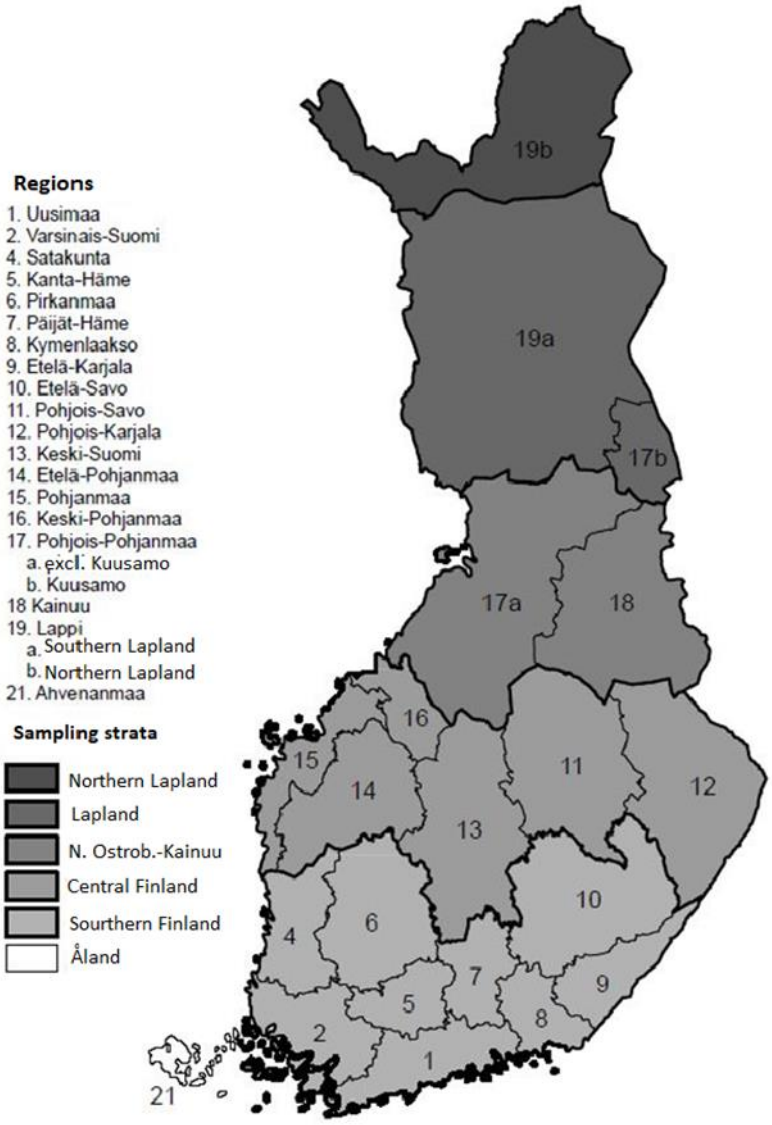
Included annexes:

1	Map of regions and NFI Sampling strata
3	Inventory working regions
4	Definitions: ground level, seedling point, breast height
11	Normative density of seedling stands and first-thinning stage stands
15	Relascope trees –maximum distance by diameter
17	Crown class classification
18	Notes for tree height measurement

Not included annexes in the translated version:

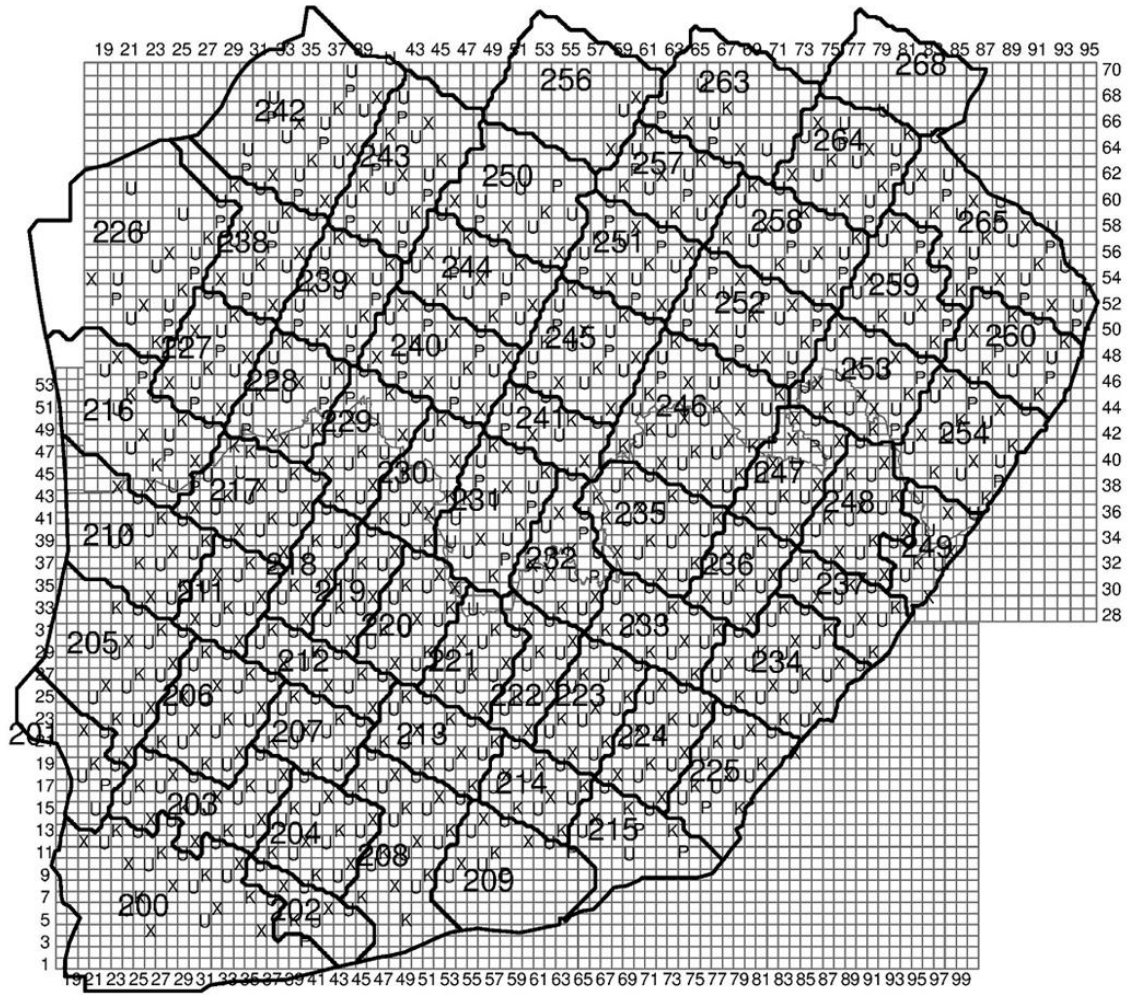
2	List of team leaders
5	Main forest types
6	Site classification
7	Mire types
8	Timber producing capacity of mires
9	Descriptions for key biotopes
10	Normative stockings of seedling stands and forest quality
13	Age of reaching the breast height, by clusters
14	Limits for over-aged forests
16	Characteristics of Betula pendula and B. pubescens
19	Determination of height growth of conifers
20	Dimensions and quality criteria for timber assortments
21	Log volume table

Appendix 1
Regions and NFI sampling strata

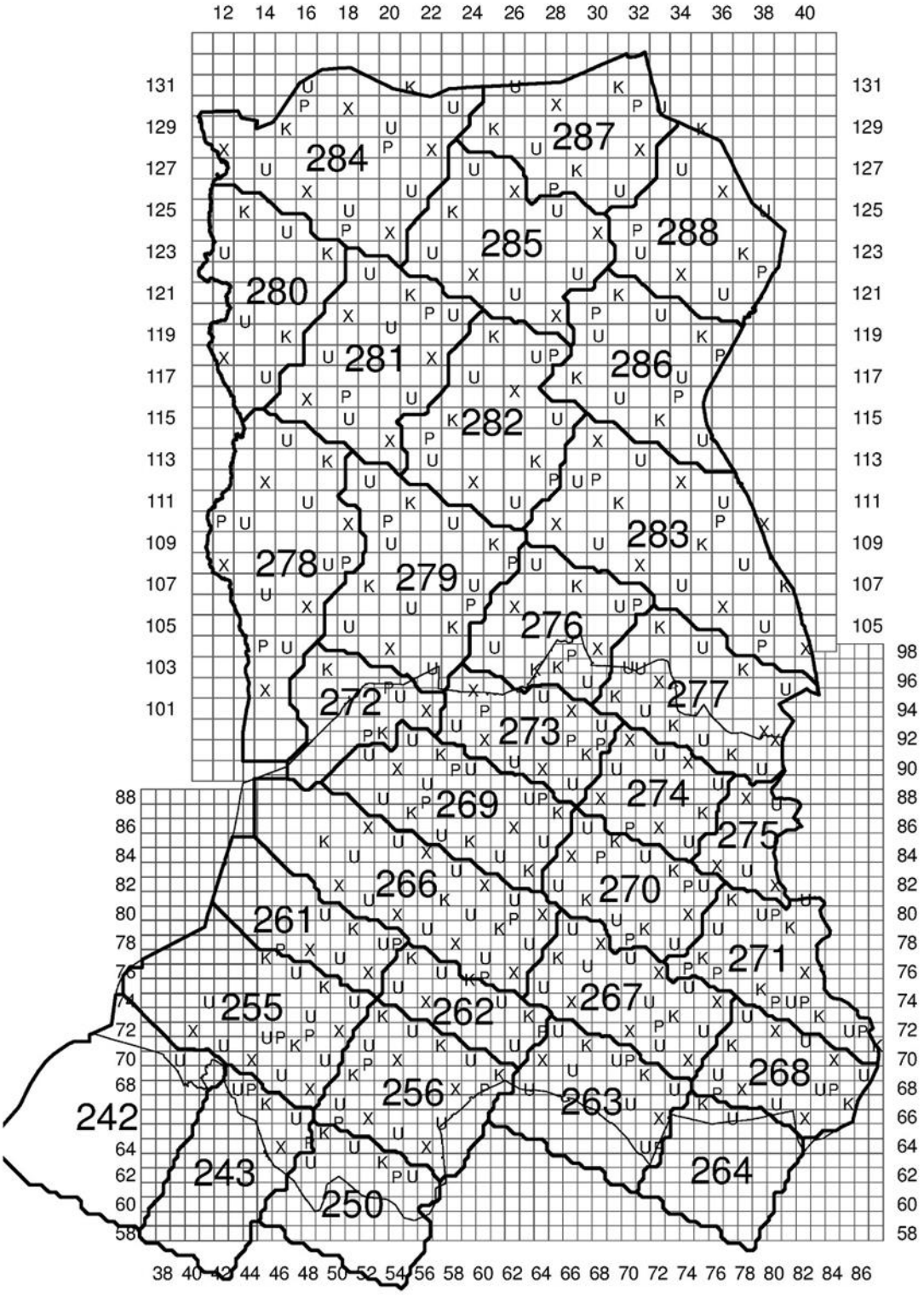


Appendix 3
Inventory working regions

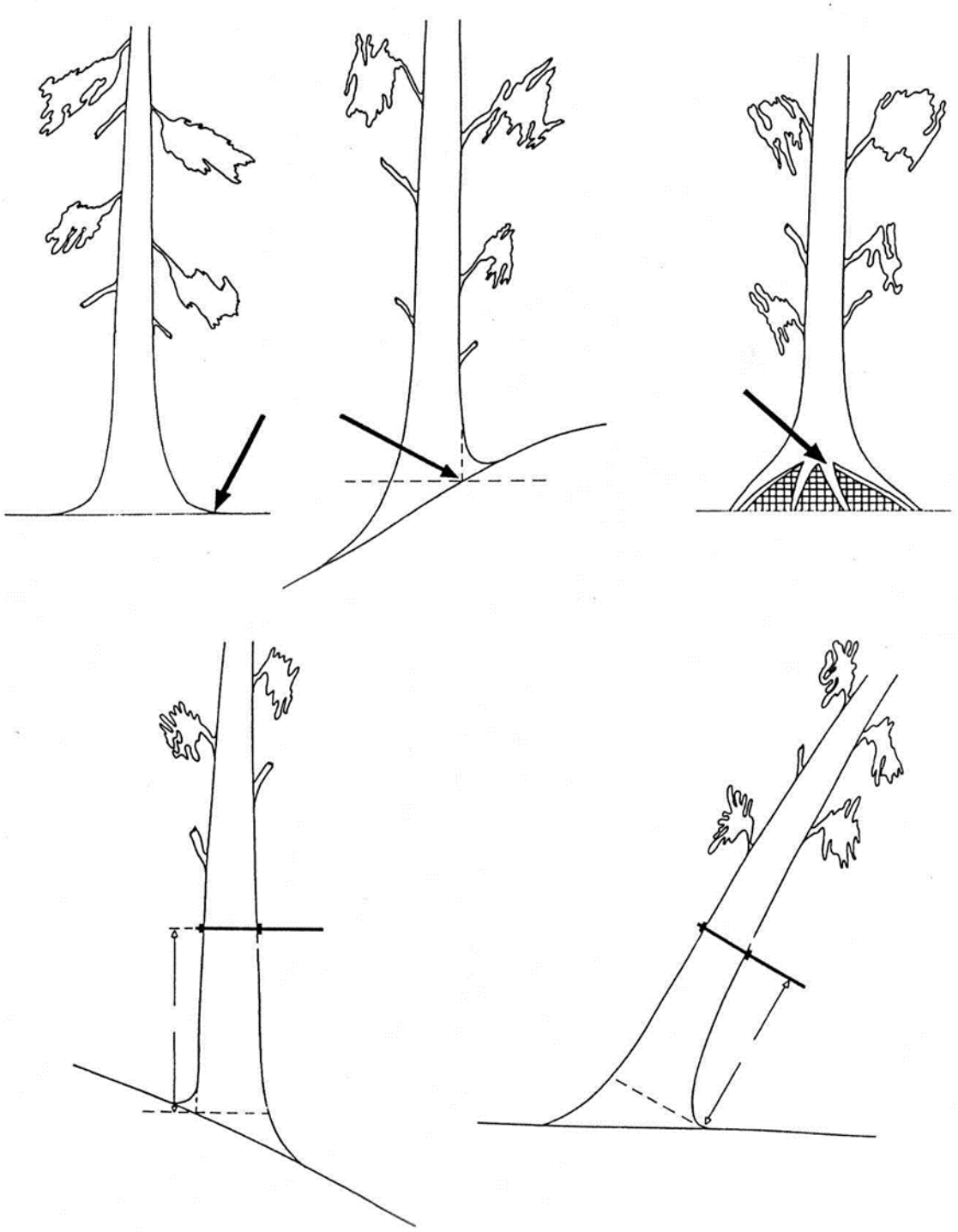
Southern Finland
Permanent clusters (P and U), new permanent clusters (X) and temporary clusters (K)



Northern Finland
Permanent clusters (P and U), new permanent clusters (X) and temporary clusters (K)



Appendix 4.
Definition of ground level, seeding point and breast height



BREAST HEIGHT DEFINITION FOR TREES ON A SLOPE AND LEANING TREES

Appendix 11
Normative density of seedling stands and young thinning stage stands

Planting densities

	Pine*	Spruce	Silver birch	Downy birch**	Larch	Aspen**
Seedlings/ha	2000 - 2400	1600 - 2000	1600	(2000)	1300	(2000)

* Sown 4000 – 5000 seedling/ha
** Downy birch and aspen not planted, planting density for hybrid aspen 1200 – 1600 seedlings/ha

Density of seedling stands

Southern and Central Finland

Dominant species	Forest site type and growing method	Mean height (m)	Seedlings (pcs/ha)
Pine	Fresh	5–7	2000–2200
	Dryish	3–4	2500–3000
	Dense sown seedlings		
	Dry	3–5	2000–2200
Spruce	Grove-like or fresh	3–4	1800–2000
	Grove-like or fresh	3–4	~ 1500
	Quick volume growth		
Silver birch	Grove-like or fresh	4–5	~ 1600
Downy birch	Fertile peatlands	4–7	2000–2500
Larch	Grove-like or fresh	4–7	~ 1300
Aspen	Grove-like	3–5	1200–1600
	Growing trees for fiber		
Aspen	Grove-like	6–8	1800–2000
	Growing trees for logs		

Northern Finland

Dominant species	Forest site type	Mean height (m)	Seedlings (pcs/ha)
Pine	Fresh, dryish or dry	3–5	1800–2200
Spruce	Grove-like or fresh	2–4	1800–2000
Downy birch	Fertile peatlands	5–8	2000–2500

First-thinnings

Recommended mean height at the time of thinning and density after the thinning in young managed forest

Southern and Central Finland

Dominant species	Forest site type & growing method	Mean height (m)	Density (stems/ha)
Pine	Fresh or dryish	10–12	1100–1400
	First thinning as 'quality thinning'		
	Fresh or dryish	13–15	900–1100
	Thinning from below		
	Dry	11–13	800–1000
	Thinning from below		
Spruce	Grove-like or fresh	13–16	900–1100
	Managed stand		
	Grove-like or fresh	16–17	700–800
	In case of one thinning during thet rotation starting density is 1200–1500 seedlings/ha		
Silver birch	Grove-like or fresh	13–15	700–800
Downy birch	Fertile peatlands	13–15	900–1200
	Tending of seedling done		
	Fertile peatlands	No thinnings	
	Growing without tending		
Larch	Grove-like or fresh	12–15	600–800
Aspen	Grove-like	No thinnings	
	Growing trees for fiber		
	Grove-like	14–16	n. 700
	Growing trees for logs		

Northern Finland

Dominant species	Forest site type and growing method	Mean height (m)	Density (stems/ha)
Pine	Fresh	10–12	1100–1400
		12–14	900–1100
Pine	Dryish	10–12	900–1100
		12–14	700–900
Pine	Dry	10–12	800–1000
		12–14	600–800
Spruce	Fresh forest heaths	10–12	1100–1400
	Fresh peatlands	12–14	900–1100
Downy birch	Fresh heaths	10–12	1000–1200
	Peatlands	12–14	800–1000
	Thinning necessary only if the focus is on growing spruce understory		

Densities recommended after thinning of unmanaged and overstocked stands not included in the translated version

Appendix 13

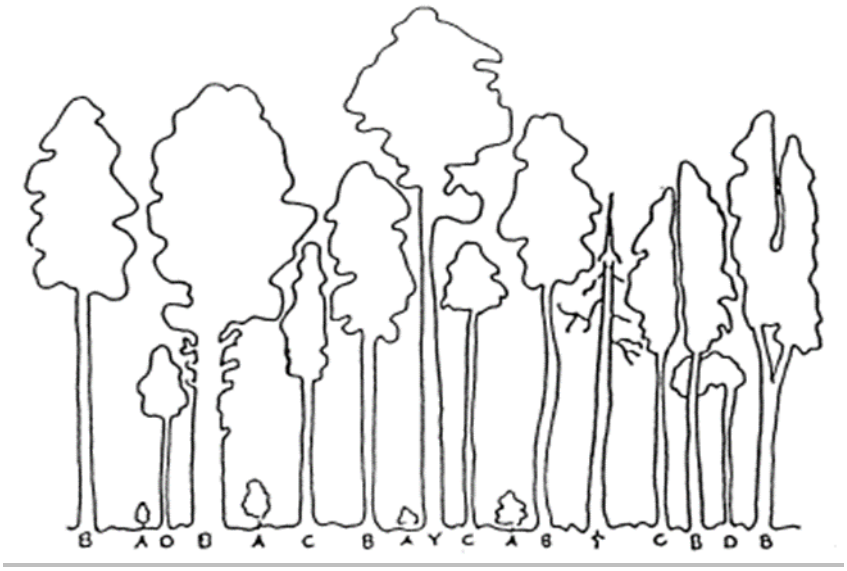
Maximum distance for trees under 45 mm as a function of diameter

Relascope factor 1.5, maximum radius 1.80 m.

Diameter at breast height, cm+mm

	mm									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
cm	**Distance to (front) side of tree, m (Max)**									
0	0.00	0.04	0.08	0.12	0.16	0.20	0.24	0.28	0.32	0.36
1	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.68	0.72	0.76
2	0.80	0.84	0.88	0.92	0.96	1.00	1.04	1.08	1.12	1.16
3	1.20	1.25	1.29	1.33	1.37	1.41	1.45	1.49	1.53	1.57
4	1.61	1.65	1.69	1.73	1.77					

Appendix 17
Crown class classification



Crown class classification

B = dominant or co-dominant tree	C = intermediate tree	D = suppressed tree
Y = over-storey tree	A = under-storey tree	

Codes (letters symbols of the storeys)

2 B Dominant or co-dominant tree of over-storey. **Dominant trees** form the uppermost layer of the storey. The class includes the highest and usually thickest trees of a storey.
Co-dominant trees form the layer a bit lower than the previous layer. The length of the trees is 80-90 % of the length of the dominant trees and their crown has usually developed more weakly than the crown of the dominant trees.

3 C Intermediate tree of the dominant storey. The length of the trees is 70-80 % of the length of the dominant trees and their crown locates between the dominant trees. From above the usually are free from shading, but suffer from shading coming from the sides and thus are usually weakly developed.

4 D Suppressed tree of the dominant storey. The length of the trees is at most 60-70 % of the length of the dominant trees. This is the lowest layer of dominant storey. The crowns are usually shaded from above and from sides and thus the trees are weakly developed.

6 Y Dominant or co-dominant tree of over storey. Tree of over storey, which fulfils the criteria given for dominant or co-dominant trees in class B description.

7 V Intermediate or suppressed tree of over storey. A tree, which includes in over storey class and fulfils the criteria given for C (intermediate tree) or D (suppressed tree).

5 A Under-storey tree. A tree, which is evidently younger that the trees in dominant layer.

Appendix 18

Notes for height measurements

- The ground level can be accurately determined by displaying a height of 1.0 m or 1.3 m of the tree.

- Height is measured at the highest point of the tree. For example, bending of the top of a silver birch is not taken into account. A round-topped tree must be measured at a sufficient distance to be able to see the top of the tree.

- The distance meter must be calibrated according to the instructions.

- If possible, the measuring distance should be greater than the height of the tree.

- The distance is measured horizontally to the exact spot below the tree top. Tilted tree is measured (if possible) so that the tilt is directly to the side. Measuring the distance of a 30 cm thick, vertical tree from the front side of the tree causes

    - 14 cm underestimation from a distance of 20 meters (20,15 m)
    - 19 cm underestimation from a distance of 15 meters (15,15 m)

- When measuring the height of a tilted tree, the position of the top (height and lateral displacement) in relation to a position of the top of a vertical tree must be taken into account. Examples of height differences and lateral displacements of tree tops are show in a table below (when tree height is 20 meters).

Tilt, degree	**20**	**15**	**10**	**5**	**2.5**	**1**
Difference of tilted and vertical tree height, m	1.21	0.68	0.30	0.08	0.02	0.00
Lateral displacement of the tree top (from tree bottom), m	6.84	5.18	3.47	1.74	0.87	0.35

- The movement of head (change in eye height) causes an underestimation of 10 to 20 cm. With the Vertex digital height gauge, the error is eliminated by setting the appropriate value for the P.Offset (Pivot Offset) parameter for each measurer.