REPORT

ON IMPLEMENTATION OF THE RESEARCH PROGRAM

ELABORATION OF FOREST REFERENCE LEVEL FOR LATVIA FOR THE PERIOD BETWEEN 2021 AND 2025

ACTIVITY

NATIONAL FOREST INVENTORY METHODOLOGY

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INTRODUCTION

Based on Forest monitoring guidelines (Latvijas Valsts mežzinātnes institūta ‘’Silava’’, 2013).

1. General Issues of the Monitoring of Forest Resources

1.1. The objectives of the monitoring of forest resources shall be as follows:

1.1.1. to obtain operational and accurate information regarding forest resources for national and international statistical needs;

1.1.2. to control the dynamics of the forest area;

1.1.3. to obtain accurate information regarding wood resources, their structure and dynamics;

1.1.4. to obtain information for assessment of the dynamics of the condition of forest ecosystems, damage to forest and biological diversity;

1.1.5. to obtain information for forecasting of the forest resources and for the needs of the GHG inventory;

1.1.6. to accumulate historical information regarding the course of development of forest stands.

1.2. The object of the monitoring of forest resources is the territory where growing and/or dead wood resources are found, regardless of the form of property.

1.3. The task of the monitoring of forest resources is to obtain the following information at large in the State and in division according to property groups (State properties and other properties):

1.3.1. forest land areas in division according to forest land categories;

1.3.2. division of areas covered with trees, outside the forest land;

1.3.3. forest stand areas and standing volumes in division according to the dominant tree species, age decades, site quality classes, height and basal area groups, limitations of economic activities and indications of nature protection, types of forest regeneration and forest types;

1.3.4. cutover areas in division according to forest types;

1.3.5. the annual increment of forest stands, the annual dead rate and the annual felled amount in division according to the dominant tree species;

1.3.6. the characterisation of damages to forest stands by the area and stock in division according to the dominant tree species and causes of damages (damages by insects, damages by disease, damages by wildlife, damages by storms, snowbreak and damages of similar types, damages by fire, other damages);

1.3.7. areas of forest stands with undergrowth in division according to the species of the undergrowth and the groups of covering;

1.3.8. areas of forest stands with advanced growth in division according to tree species and groups of covering;

1.3.9. areas and stocks of the forest land covered with trees and bushes, but not forming a forest stand, in division according to tree and bush species;

1.3.10. the total biomass of the wood (wood stock of growing trees and bushes and deadwood and biomass above the stump in division according to tree species, their stumps, roots, as well as biomass of the fallen deadwood) in division according to tree species;

1.3.11. information regarding wood resources growing outside the forest and their dynamics.

1.4. Information shall be collected in accordance with the definitions of the Forest Law and the Temperate and Boreal Forest Resources Assessment.

INVENTORY UNITS

1.5. Inventory unit network of the monitoring of forest resources

1.5.1. The monitoring of forest resources shall be carried out according to the principle of bi-level selection:

1.5.1.1. a network of sample plots shall be created in the first level selection. Sample plot tracts with four sample plots in each shall be selected;

1.5.1.2. sample plot tracts shall be laid out evenly throughout the State territory in 4 x 4 km distance from each other following the principle that they form an equilateral triangle (Figure 1). Each year one fifth of all sample plots shall be surveyed, ensuring impartial layout of annual surveys evenly throughout the State territory;

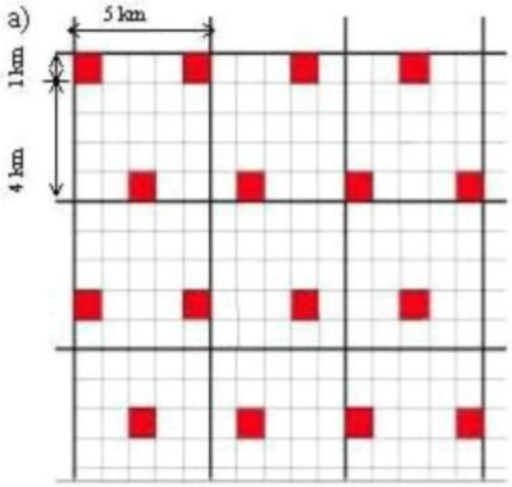

Figure 1 Scheme of the Layout of Sample Plot Tracts.

1.5.1.3. sample plot tracts shall be laid out on a network of orthophoto map sheets (Figure 2). Sample plots shall be laid out in sample plot tracts, grouping them by four in one tract. Sample plots within the scope of a tract shall be laid out in vertices of a 250 x 250 m square;

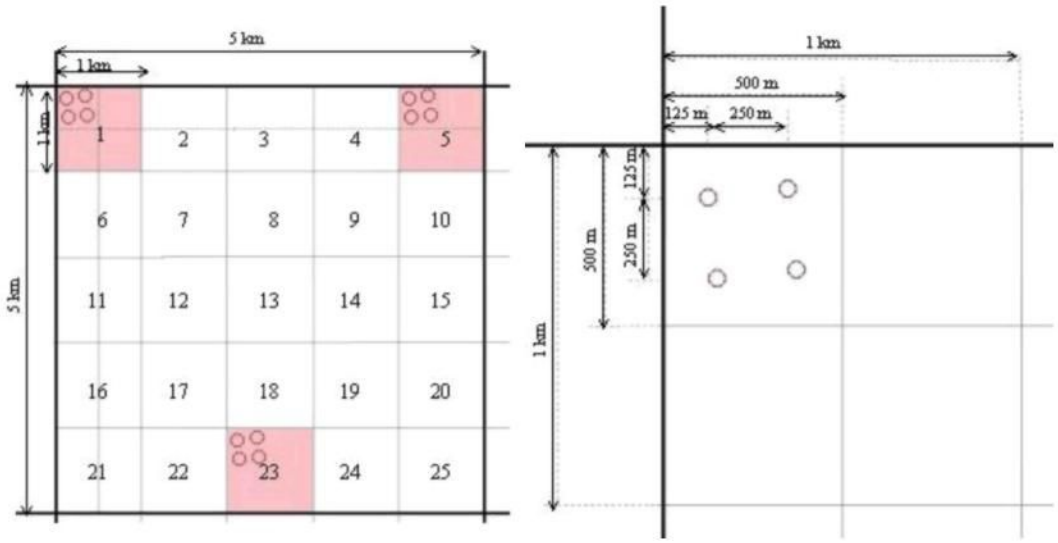

Figure 2 Tract and sample plot selection scheme on orthophoto map sheets

1.5.1.4. in the second level of selection inventory trees shall be selected in all sample plots selected in the second round in order to assess the height, age, increment, quality and damages. Such trees shall be selected in proportion to the size (diameter) of the existing trees. The intensity of selection shall be 20-30% for all trees for which the diameter is measured;

1.5.2. a sample plot network shall be created according to a systematic layout scheme with a randomly selected reference point. Each sample plot shall be surveyed once during a complete cycle of the monitoring of forest resources, i.e., once every five years;

1.5.3. in performing re-measuring in sample plots, changes during a time period of five years shall be assessed. Annual indicators shall be obtained by dividing the total changes in the re-measurement period by the number of years of the time period.

1.6. Inventory element scheme

1.6.1. Inventory sample plots in a sample plot network shall be laid out in tracts, which have edges of 250 m in length and they are oriented in the direction of the North, East, South and West. The centre of the sample plot shall be deviated from the vertex of the tract by 25 m counter-clockwise (Figure 3);

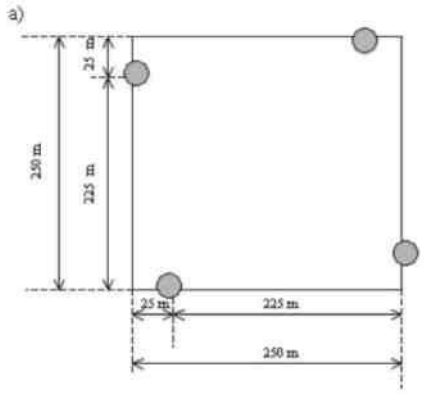

Figure 3 Layout Scheme of Sample Plots

1.6.2. The main element of inventory is a permanent inventory sample plot of a fixed radius, the area of which is 500 m² (radius in a plane is 12,62 m) and in which trees, as well as fallen deadwood with diameter of 14,1 cm or more are surveyed (Figure 4).

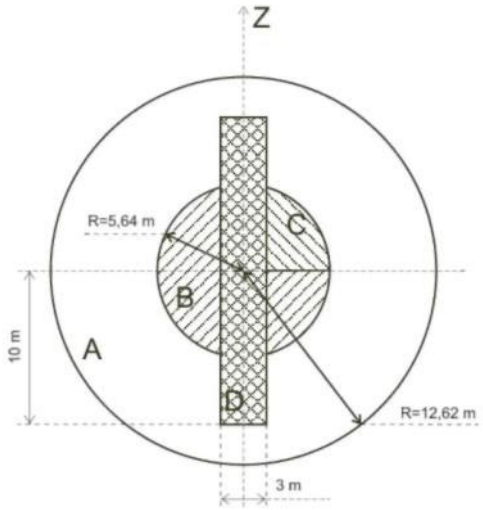

Figure 4 Sample Plot Scheme (A – 500 m² sample plot, B – 100 m² sample plot, C – 25 m² sample plot, D – sample plot of undergrowth and advanced growth inventory)

1.6.3. A second sample plot shall be earmarked at the centre of the sample 100 m² plot (R= 5,64 m) in which all trees and fallen deadwood with the diameter of the butt-end 6,1 cm or more shall be surveyed. All trees of natural origin and their outgrowth, the diameter of which in height of 1,3 m above the root collar (hereinafter – in height of 1,3 m) is 2,1 cm, shall be surveyed in the first fourth of such sample plot, calculating from the northern direction (25 m²);

1.6.4. the undergrowth and advanced growth shall be determined in a zone of the sample plot of 3 x 20 m, earmarked in a joint sample plot, in sample plots No. 1 and No. 3 in the eastern-western direction, in the sample plots No. 2 and No. 4 in the northern and southern direction;

1.6.5. fallen deadwood shall be surveyed at odd times of re-measuring of sample plots.

1.7. Earmarking of sectors into sample plots

1.7.1. Sectors shall be earmarked in a sample plot if:

1.7.1.1. they are a different form of property;

1.7.1.2. they are the territory of another state;

1.7.1.3. they have a different type of the use of land;

1.7.1.4. they are a different category of the forest land;

1.7.1.5. they have a different origin of the forest stand;

1.7.1.6. they are a different type of forest;

1.7.1.7. the age difference of forest stands exceeds 20 years;

1.7.1.8. the composition of species forming Level I of the stand differs by four or more units;

1.7.2. In identifying sectors of a sample plot, their point azimuths and distances to the centre of the sample plot in which the line dividing the sectors is crossing the border of the sample plot shall be recorded. In case of several breaking points of the line dividing sectors azimuths and distances to each breaking point shall be recorded.

1.8. Numbering of tracts and sample plots

1.8.1. The ten-digit identification number of sample plots shall consist of the tract number and the sample plot number.

1.8.2. Sample plot tracts shall be numbered according to the division sheets of the TKS-93 map sheet nomenclature system in the scale 1:1000 corresponding to geographical areas and shall be formed from numbering symbols 1-9.

1.8.3. The tenth symbol in the identification number shall be the number of the sample plot in the tract.

1.8.4. Sample plots within the scope of a tract shall be numbered from to "4" clockwise (Figure 5).

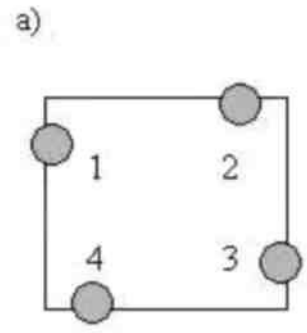

Figure 5 Numbering Scheme of Sample Plots

1.9. Determination of co-ordinates of the tract and sample plot centre

1.9.1. The Latvian Co-ordinate System is defined with the following parameters:

Ellipsoid	WGS84

Projection	Transversa Merkatora
Central meridian	24
Scale coefficient on meridian	0,9996
Deviation along x-axis	500 000 m
Deviation along y-axis	–6 000 000 m

1.9.2. The following co-ordinates of the centre of sample plot tracts have been determined according to the Latvian Co-ordinate System:

1.9.2.1. the co-ordinates of centres of sample plot tracts shall be calculated according to orthophoto map sheets and the scheme presented in Figure Sample plot tracts for the 5 x 5 km sheet of orthophoto maps in the centre of Latvia shall be laid out in three centres of 1x1 km squares. Co-ordinates of the subsequent tract centres in the distance of 4 km for the whole domestic territory of Latvia shall be calculated for the three sample plot tracts in the northern, eastern, southern and western direction in the central orthophoto map sheet of Latvia;

1.9.2.2. all co-ordinates of the next tract centre shall be calculated, using the co-ordinates of the adjacent tract centre and using the causations (1) and (2):

Xn = Xi ± 004.000.00 or Xn = Xi (1)

Yn = Yi ± 0.004.000.00 or Yn = Yi , where (2)

Xi – co-ordinates of the width of the previous vertex;

Yi – co-ordinates of the length of the previous vertex.

1.9.3. Co-ordinates of sample plot centres shall be calculated according to co-ordinates of tract centres in conformity with the principle that the tract centre is the centre of a 250x250 m square at the corners of which sample plots are placed. In addition the offset of the centre of the sample plot from corners of the square by 25 m shall be calculated, as shown in Figure 3.

ORGANISATION OF MONITORING OF FOREST RESOURCES

1.10. Organisation of the monitoring of forest resources

1.10.1. Periodicity of the monitoring of forest resources

1.10.1.1. The monitoring of forest resources shall be carried out each year in the whole territory of Latvia.

1.10.1.2. The sample plot network shall be gradually increased for the first five years, surveying one fifth of the total number of sample plots each year.

1.10.1.3. During each next five years sample plots and inventory trees therein shall be re-measured. The time period between re-measuring of sample plots shall be five years +/-20 days.

1.10.2. Preparation works of the monitoring of forest resources

1.10.2.1. Preparation works shall be carried out in order to ensure timely and successful commencement and course of field works fromJanuary untilApril.

1.10.2.2. The following information shall be aggregated during the preparation works:

1.10.2.2.1. using orthopohoto maps (not more than five years old), compile a list of the sample plots to be surveyed on the site during the working year;

1.10.2.2.2. prepare print-outs of the cartographic material – print-outs of orthophoto maps S 1:10 000 forest land plans (copies) S 1:10 000 and cadastral maps, print-out of a satellite map S 1:50 000 which characterises the situation in order to reach the relevant tract;

1.10.2.3. work forms shall be prepared in each next cycle of measurements, and they shall include the information on measurements from the previous cycle (the azimuth of the surveyed tree, the distance to the centre of the sample plot, the diameter in height of m and the measured height of the tree);

1.10.2.4. the measuring instruments necessary for the field work season shall be prepared.

1.10.3. Organisation of field works

1.10.3.1. Measuring of sample plots in a forest shall be carried out by five field work groups.

1.10.3.2. A field work group shall consist of a leader and an engineering technical employee. The leader of the group shall organise the group work, trips, routes, finding and measuring of a tract in sample plots, shall be responsible for any documentation, as well

as take care of the transport, measuring instruments, storing and inspecting thereof.

1.10.4. Quality control of field work

1.10.4.1. Field work shall be controlled:

1.10.4.1.1. in order to prevent surveying errors and the causes for occurrence thereof;

1.10.4.1.2. in the amount of at least five per cent from the number of permanent sample plots surveyed by each working group a year;

1.10.4.1.3. by an individual working group in the composition of two people.

1.10.4.2. In field work control all such indicators of the sample field shall be surveyed in the sample field, which are repeatedly measured during re-measuring (tree azimuth, distance, diameter at height of 1,3 m, height, undergrowth and advanced growth).

METHODOLOGY OF FIELD WORKS

2. Methodology of field work of the monitoring of forest resources

2.1. Identification of sample plots on the site

2.1.1. The centre of sample plots on the site shall be found with the help of the global positioning system (hereinafter – GPS) according to the calculated co-ordinates, using it in navigation (point search) mode.

2.1.2. In case if it is not possible to find the centre of the sample plot with a GPS receiver (poor detection capability in forest conditions), then the point co-ordinates shall be determined in the closest open place where taking of GSP measurements is possible. Afterwards the distance and the azimuth to be followed shall be determined in order to identify the theoretical point. Then the centre of the sample plot shall be found, using a measuring tape and compass.

2.1.3. If a line must be marked off in a relief slope, the distances measured in the slope towards horizontal plane shall be recalculated, using trigonometric causations of a right-angled triangle. The angle of the relief slope and the distance between points must be measured and the distance in a plane must be recalculated.

2.1.4. All sample plots and their parts, which are planned for measuring in forest land, shall be divided into accessible and non-accessible after inspection on site. Such sample plots shall be considered as non-accessible, the centres of which cannot be reached due to different reasons – they are located in water reservoirs, marshes, etc.It shall be noted in the notes of the description of the sample plot.

2.1.5. The characteristics of sample plots with non-accessible centres shall be determined, performing measurements for trees outside the sample plot, performing the necessary measurements in plots the centre of which is located as close to the theoretical centre of the sample plot as possible. In such case the location of the sample plot centre used for measurements shall be described in the note section, marking the closest trees around it.

2.1.6. If the sample plot is accessible, however, its centre coincides with an obstacle (stone, asphalt, etc.), the centre of the sample plot shall be marked as close from the theoretical centre as possible, marking the closest trees around it, however, measurements shall be performed from the theoretical centre. Similar actions must be taken, if the centre of a sample plot touching the forest is in arable land or on an object of the forest infrastructure where destruction of the mark of the centre is possible. Such changes shall be recorded in the note box of the documents, drawing a sketch of the marked centre.

2.1.7. In establishing a permanent sample plot on the site, one must follow the principle that it should attract as less attention during the time period until the next survey time as possible. After the survey of the sample plot, a metal bar shall be driven in the centre thereof.

2.1.8. Trees shall be marked around the centre of the sample plot, driving nails in their root collar, leaving at leastcm of the nail above the root collar and bending it.

2.1.9. If it is not possible to mark the centre of a sample plot with the help of trees or stumps in the sample plot (for example, young stands), then other trees outside the sample plot shall be looked for.

2.1.10. Identification of the centre of a sample plot shall be documented, indicating the tree species used for identification, its distance from the centre of the sample plot and the azimuth.

2.1.11. In repeatedly surveying sample plots, their centre shall be found with the help of a metal detector, at first finding the trees marked for ensuring identification. After the trees (or their stumps) of identification are found, using their azimuth and distance, the place where the metal bar was driven in shall be found.

2.2. Division of sample plots into sectors

2.2.1. In dividing a sample plot into sectors, the following principles must be complied with:

2.2.1.1. the whole zone of the road belongs to roads. If a road zone is also used for other purposes (electricity, communications line, fireline, ditch), then they shall be included in the main function – road;

2.2.1.2. if there are only such ditches next to a forest road, which serve only the road, then they shall be included in the area of the road;

2.2.1.3. if there is a territory not covered with forest growth next to an embankment of a forest road and the forest, exceeding 4 m in width, it shall be treated as a glade;

2.2.1.4. ditches shall be classified into two different categories: ditches belonging to the forest land and field ditches. A ditch separating forest land from other land shall be divided into two different sectors (forest ditch and field ditch) according to the bottom line of the ditch;

2.2.1.5. ditch routes are the linear object of the forest land. The status of a ditch route shall only be assigned if the width thereof is not less than 4 m and not more than 10 m;

2.2.1.6. the beginning of the ditch route shall be measured from the beginning of the ditch edge (side);

2.2.1.7. if the edge of the ditch is rounded-off, the beginning thereof shall be determined according to the displacement of the land surface plane from the plane of the ditch edge, but not farther thanm from the line where the land plane and ditch edge plane projections are intersecting;

2.2.1.8. if the distance from the ditch edge (side) to the forest is less than 4 m, the sector of ditch route shall not be earmarked and the territory shall be included in the ditch;

2.2.1.9. if a group of trees is less than ha or forms a zone that is narrower than 20 m, it shall be itemised as separate trees in an adjacent land category;

2.2.1.10. the owner of the forest roads shall be determined, taking into account the owner of the surrounding land;

2.2.1.11. linear objects of the forest land, which are located on the border with different properties, shall be divided into sectors with corresponding property rights according to the centre line;

2.2.1.12. measurements shall be taken by marking the number of the sector during measuring, and it shall be the basis for the performance of subsequent calculations;

2.2.1.13. the measurements to be taken for identification of sample plot sectors shall be documented.

2.3. Laying out of sample plots

2.3.1. If the border of a sector divides sample plots of m², m², 25 m², 60 m², inventory of trees of corresponding diameter, undergrowth and advanced growth shall be carried out according to sectors.

2.4. Determination of common characteristics in a sample plot

2.4.1. Determination of the forest type

2.4.1.1. In each sample plot or sector of the forest and cutover the forest type of the forest stand corresponding thereto shall be determined, using the Latvian forest typology developed by K. Bušs (Bušs K. (1981) Meža ekoloģija un tipoloģija. Rīga: Zinātne, 65 lpp.).

2.4.2. Inventory of advanced growth and undergrowth

2.4.2.1. Advanced growth and undergrowth shall be itemised in all sample plots.

2.4.2.2. The trees of the forest element which while being 1,3 m in height have not reached cm in diameter shall be included in the advanced growth. If a forest element with a diameter of less than 2,1 cm forms a dominant stand, its trees shall not be included in the inventory of the advanced growth.

2.4.2.3. The undergrowth and the advanced growth shall be itemised in a zone that is 20 m long and 3 m wide. Sectors may also include a smaller plot or no plot at all. The inventory plot of the undergrowth belonging to sectors shall be determined in office work.

2.4.2.4. The number of species and specimens for undergrowth and advanced growth trees, as well as the height and diameter of a visually selected average woody plant in the middle of it shall be determined.

2.4.2.5. The average age shall be determined for each undergrowth and advanced growth species – branch whorls shall be itemised or a

tree shall be sawn outside the sample plot and its growth rings shall be counted. During inventory of the undergrowth and advanced growth all sprouts which have grown up from the earth or stump shall be counted.

2.5. Surveying of growing trees

2.5.1. Selection of inventory trees

2.5.1.1. Inventory trees shall be selected from the living trees in the sample plot, the diameter of which has been measured in height of 1,3 m. If an individual element of the stand is formed only by deadwood, the inventory trees shall also be measured for them. Generally not less than one tree out of seven trees should be selected.

2.5.1.2. If only one tree species is represented in the sample plot, then trees 3-5 from Kraft Class I, also 3-5 trees from Kraft Class II and Kraft Class III trees, as well as 1-2 trees from Kraft Classes IV and V shall be selected as inventory trees. If there is the second level in the stand, which is represented by one tree species, then at least three trees shall be selected as inventory trees. Inventory trees shall be selected in such a way that they have different diameters;

2.5.1.3. If several tree species are represented in the sample plot, then 2-3 trees from Kraft Classes I-III and 1-2 trees from Kraft Classes IV and V shall be selected as inventory trees for each of such species. If there is the second level in the stand, which is represented by more than one tree species, then at least 1-3 trees from each species shall be selected as inventory trees.

2.5.1.4. If the number of forest element trees in the sample plot is very high, then not less than one tree out of seven trees shall be selected. In selecting trees for inventory the third tree, then the 10th tree, the 17th tree, etc. shall be selected. If a sufficient number of inventory trees is not collected systematically, then the missing trees shall be selected from thicker trees.

2.5.1.5. Additional measurements shall be taken for inventory trees – the height of trees shall be determined, as well as the diameter of the tree at the root collar, the height of the first green branch, the height of the first dry branch shall be determined at each odd time of re-measuring.

2.5.1.6. In re-measuring sample plots, the same inventory trees shall be measured. Felled trees or deadwood shall be replaced with the next corresponding Kraft Class tree.

2.5.2. Determination of the distance of the tree to the centre of the sample plot

2.5.2.1. The distance from the centre of the sample plot to the centre of the tree in height of 1,3 m in horizontal direction shall be measured with the help of an ultrasonic measuring device.

2.5.2.2. The belonging of trees (growing trees, deadwood, fallen trees) to a sample plot shall be determined by their diameter in height of 1,3 m.

2.5.2.3. A stand shall be mounted at the centre of the sample plot, to which an ultrasonic reflector shall be attached, for the determination of the distance. The source of ultrasound with the measurement indicator shall be held horizontally to the reflector by the central axis of the tree.

2.5.2.4. The distance of only standing trees to the centre of the sample plot shall be recorded in the inventory card of trees.

2.5.2.5. The distance for fallen trees shall be measured only to determine their belonging to the sample plot.

2.5.3. Determination of azimuth in order to identify the location of the tree

2.5.3.1. Azimuth of a tree shall be measured from the centre of the sample plot with an instrument intended for measuring of angles (compass), which has been secured with the help of a stand, with accuracy of 1^0.

2.5.3.2. The stand shall be aligned at the centre of the sample plot with the help of a weight. The direction for trees which have toppled shall be determined according to the line connecting the centre of the sample plot with an imaginary perpendicular line drawn towards the centre of the stump.

2.5.3.3. Azimuth shall be registered as an instrument reading, without taking into account the magnetic variation.

2.5.3.4. Azimuth shall be measured only for growing trees and snags, azimuth need not be measured for stumps and fallen trees.

2.5.3.5. Surveying of trees shall begin from magnetic North, clockwise.

2.5.4. Determination of the distance of the tree to the centre of the sample plot

2.5.4.1. The distance to the tree shall be measured in height of 1,3 m, towards the axis line of the tree (half of the diameter). If the tree is located in a relief slope, then the distance to it shall be measured towards height of 1,3 m (parallel to the land surface), determining the land surface angle and recalculating the distance on the horizontal plane.

2.5.4.2. If due to a poor visibility of the tree (accurate determination of azimuth or measuring of the distance is hindered by the projection of another closer tree bole) or it is not possible to take an accurate measurement of the diameter of the tree in height of 1,3 m, the reason for the possible error shall be noted in the "Notes" of the tree measurement sheet.

2.5.5. Determination of the characteristics of a tree bole

2.5.5.1. Measurement and assessment of trees and stumps shall be performed in each sample plot or sector, which falls into forest,

forest land or also an area covered with trees outside the forest land.

2.5.5.2. The following shall be determined for each tree and entered in the tree inventory table:

2.5.5.2.1. the distance of the tree to the centre of the sample plot (+/- 1 cm);

2.5.5.2.2. the tree azimuth (+/- 1^0);

2.5.5.2.3. the species (according to the classifier);

2.5.5.2.4. the level;

2.5.5.2.5. the Kraft Class;

2.5.5.2.6. the diameter of the tree in height of m (+/- 1 mm);

2.5.5.2.7. the diameter of the tree for inventory trees at the root collar (+/- 1 mm) (at each odd time of re-measuring);

2.5.5.2.8. the height of the tree for inventory trees (+/- 0,5 m);

2.5.5.2.9. the height of the first green, first dry branch (+/- 0,5 m);

2.5.5.2.10. damages (type of the damage, intensity of the damage, height (location on the tree)).

2.5.6. Determination of the level of a tree

2.5.6.1. For each tree diameter of which is measured belonging to the first or second level shall be determined.

2.5.6.2. All trees height differences of which do not exceed 20% shall be joined in the first level. Other trees shall form the second level, if their height is not less than one fourth of the height of the first level trees.

2.5.6.3. Trees of the advanced growth, diameter of which exceeds 2,1 cm and which do not belong to the second level, shall be marked as the trees of the third level. Measurements in relation to these trees shall be used in order to determine the total amount of biomass.

2.5.7. Determination of the Kraft Class

2.5.7.1. The Kraft Class shall be determined for each tree of the first level, for which the diameter is measured. Kraft Classes shall be grouped according to the following principles:

2.5.7.1.1. Kraft Class I – pre-dominant trees – the tallest and thickest trees of the stand, which have a well-developed crown and the tops of which overlook the joint canopy of the stand, shall be included in the dominant stand;

2.5.7.1.2. Kraft Class II – dominant trees – form the main canopy of the stand, their boles have slightly smaller dimensions than Kraft Class I trees. Such trees shall

form 20-40% of the total number of trees, and their stock shall form 40-70% of the total stock of the stand, they shall be included in the dominant stand;

2.5.7.1.3. Kraft Class III – co-dominant trees – crowns of trees are relatively less developed, narrower, squeezed in between crowns of Kraft Class I and II trees and are located at the lower part of the joint canopy, however, they shall be included in the dominant stand;

2.5.7.1.4. Kraft Class IV – suppressed trees – tree crowns are shorter and narrower than those of Kraft Class III trees. They reach the lower part of the main canopy with theirs tops. Trees fall significantly behind Kraft Class I-III trees by dimensions, they are much thinner and shorter, they shall be included in the dominated stand;

2.5.7.1.5. Kraft Class V – very suppressed trees – are located below the dominant canopy of the stand, their crown is either dying off or has already died off, they shall be included in the dominated stand.

2.5.8. Determination of the diameter of a tree

2.5.8.1. For all trees in the sample plot, which have reached the diameter of 2,1 cm in height of 1,3 m, the diameter shall be measured in height of 1,3 m with accuracy of 0,1 cm.

2.5.8.2. The place where the diameter was measured shall not be marked on trees.

2.5.8.3. In measuring the diameter of a tree, the following provisions of measuring shall be conformed to:

2.5.8.3.1. the place where the diameter will be measured in height of 1,3 m shall be determined using a ruler that is 1,3 m long. If trees branch lower than in height of 1,3 m, diameters of two trees shall be measured. If there is a scar or a protuberance at the height of 1,3 m, then the diameter shall be measured above and below this place, recalculating the average value afterwards;

2.5.8.3.2. the diameter shall not be measured for trees, which have not reached the diameter of 2,1 cm in height of 1,3 m;

2.5.8.3.3. if tree is located on the border of the sample plot, then its diameter in height of 1,3 m from the root collar shall be measured;

2.5.8.3.4. if the vertical axis of the tree is located in the sample plot, then it shall be surveyed, if it is located outside the border of the sample plot, it shall not be surveyed;

2.5.8.3.5. the diameter of all trees shall be measured including

the bark; if trees are without bark, for example, dead, then the diameter shall be measured without bark and a relevant note shall be made in the note box.

2.5.9. Determination of the height of a tree

2.5.9.1. Height shall be measured only for trees selected for inventory and for all snags.

2.5.9.2. The total height of a tree shall be measured, as well as the height of the first green branch and the height up to the first dry branch at least 2 cm in width shall be measured at every odd time of survey.

2.5.9.3. The height shall be measured with the height measuring device, with accuracy of m.

2.5.9.4. The height of a tree shall be measured from the place where the top of the tree is accurately visible.

2.5.9.5. In case if a tree is growing obliquely, the distance for taking of the measurements of height shall be determined from the place located athwart to the top from the ground. Height shall be measured from the place towards which the slope of the tree is oriented. Generally, if it is possible to select a corresponding inventory tree, the height of oblique trees shall not be measured.

2.5.9.6. In determining distance from the perpendicular projection of the top of the tree to the centre of the tree bole, it is possible to calculate the length of the tree.

2.5.9.7. The height projection of a tree H_v in vertical plane and the distance of the top from the base H_h shall be measured. The height of a tree shall be calculated using the formula (5):

$$H=\sqrt{H_v^2+H_h^2}$$, where (3)

- H_v – height projection of a tree in vertical plane;
- H_h – distance of the top from the base.

2.5.9.8. The height of the beginning of the crown shall be measured in the same way. The beginning of the crown shall be determined according to the first green branches growing from the bole.

2.5.10. Determination of radial increment and age

2.5.10.1. Radial increment (hereinafter – increment) shall be determined using the method of drill holes during the first cycle of survey for such forest elements, the average diameter of which exceeds 10 cm.

2.5.10.2. Increment and age for trees shall be determined outside the sample plot in the same forest stand to which the trees of the sample plot (sector) belong. If trees corresponding to the forest element are not located outside the sample plot, trees of the sample plot shall be drilled, returning the core back into the drill

hole and smearing the drill hole up with grafting wax.

2.5.10.3. For forest elements, the average diameter of which is less than cm, the increment shall be determined as the division of the forest element stock by the age of the forest element. For such purpose the average tree selected by estimation by sight shall be sown outside the sample plot in height of m and the growth rings shall be counted.

2.5.10.4. The age of forest elements, the diameter of which exceeds 10 cm, shall be determined in the following way:

2.5.10.4.1. if there are more than 40% in the stand of the forest element stock, two trees shall be drilled until the pith for determination of age. If the age difference is more than 15 years, a third tree shall be drilled;

2.5.10.4.2. if the forest element stock in a stand is less than 40%, one average tree selected by estimation by sight shall be drilled for determination of age;

2.5.10.4.3. age shall be determined for all forest elements.

2.5.10.5. In order to determine increment, trees in addition to those trees for which age has been determined shall be drilled. Width of growth rings of the last 5 and 10 years shall be measured for determination of increment.

2.5.10.6. The last growth ring shall not be measured for determination of increment – measuring shall be commenced from the end of the latewood layer of the previous year.

2.5.10.7. At least five trees shall be drilled for determination of increment for each forest element. If the necessary number of increment trees is not found on the sample plot and its vicinity, a smaller number of trees shall be drilled.

2.5.10.8. Drilled trees must represent as different diameters as possible. Generally increment shall be determined for the 1-2 thinnest, 1-2 thickest and 2-3 medium trees of the stand (including trees drilled for determination of age).

2.5.10.9. A drill hole for determination of the width of growth rings shall always be made in the thickest place of the bark.

2.5.10.10. Drill holes for determination of the width of growth rings, if possible, shall not be made in eccentric trees. If a drill hole must be made in trees damaged by wildlife, the drill hole shall be made on the opposite side of the tree.

2.5.10.11. Width of the last 5 years and 10 years (for coniferous trees and oak, ash with accuracy of mm, other tree species – with accuracy of 0,5 mm), as well as bark thickness up to the growth ring of the current year shall be recorded in the forest.

2.5.10.12. In determining age for rotten trees, in addition the thickness of the part of the wood from the end of the bark to the beginning of

rot shall be determined.

2.5.10.13. The current increment of a forest element in re-measuring cycles shall be determined as the difference of the living tree stock between survey times.

2.5.10.14. Age of a forest element in re-measuring cycles shall be determined:

2.5.10.14.1. adding five years to the previously determined age;

2.5.10.14.2. if the forest element was not surveyed during the last time of survey, its age shall be determined according to the methodology described in this Chapter.

2.5.11. Description of forest stands, if the diameter of a dominant stand is less than cm

2.5.11.1. In forest stands, in which the diameter of dominant tree species in height of m has not reached cm or the height has not reached m, trees shall be measured as follows:

2.5.11.1.1. the average tree of the forest element shall be selected;

2.5.11.1.2. the height of the average tree shall be determined;

2.5.11.1.3. the diameter of the average tree in height of 1,3 m shall be determined:

2.5.11.1.4. if height of 1,3 m has been reached, the diameter shall be measured; if the diameter is less than 1 cm, it shall be marked as 1 cm;

2.5.11.1.5. if height of 1,3 m has not been reached, the diameter shall be marked as 1 cm.

2.5.11.1.6. Any element of the forest stand shall be marked with one measured and described tree, azimuth and marking the distance from the centre of the sample plot with 1.

2.5.11.1.7. In forest stands, in which the height of the dominant tree species has not reached height of 1,3 m, the age of trees shall be determined at the root collar; for planted trees the age of the plant need not be taken into account, if determination thereof is possible.

2.5.12. Determination of damages to trees

2.5.12.1. A note regarding damages shall be made for each tree in the sample plot.

2.5.12.2. The following shall be indicated for a damaged tree – the type, intensity, location of the damage (location on the tree). The name of the damage shall be indicated according to the classifier.

2.5.12.3. The following types of damages shall be recorded:

2.5.12.3.1. damages by insects;

2.5.12.3.2. damages by diseases;

2.5.12.3.3. damages by wildlife;

2.5.12.3.4. damages by wind, damages by snow and damages caused by other abiotic factors;

2.5.12.3.5. damages by fire;

2.5.12.3.6. damages by water;

2.5.12.3.7. other, including anthropogenic damages.

2.5.12.4. Damages shall be characterised as follows in detail:

2.5.12.4.1. damages to the bole (tumour, other diseases, scares resulting from damages by wildlife, etc.) – shall be registered if vertical projection of the damages at the widest places forms more than% of the bole perimeter). All scars located one above the other shall be considered one scar. If scars are located horizontally, their width shall be added up;

2.5.12.4.2. gnawed off sprouts, buds, needles, leaves or sprouts, buds, needles, leaves otherwise damaged by wildlife and diseases – until 10 years of age shall be registered itemising each damage at the vertex of the bole. Damages to the remaining part of the bole shall be recorded, if they form 20% or more;

2.5.12.4.3. if a tree has died, the intensity of the damage shall be noted as and the tree shall be included in the dead group “snags”;

2.5.12.4.4. if the tree has a broken top, but the crown is alive and the tree keeps growing, the intensity of the damage shall be noted as 99.

2.5.12.5. Intensity of the damage shall be assessed as follows:

2.5.12.5.1. damages to the bole – width of the damage (%) from the tree perimeter;

2.5.12.5.2. gnawed off or otherwise damaged sprouts, buds, needles, leaves – percentage of damages from the total number.

2.5.12.6. The place of the damage shall be indicated as a part of the tree where the damage is recorded. The following places of damages shall be indicated:

2.5.12.6.1. roots and stumps up to cm above the root collar;

2.5.12.6.2. the lower part of the bole from the height of the stump up to the first green branch;

2.5.12.6.3. whole bole from the height of the stump up to the top;

2.5.12.6.4. the upper part of the bole from the first green branch up to the top;

2.5.12.6.5. the top;

2.5.12.6.6. branches in the living crown;

2.5.12.6.7. branches which have grown out of the bole and are more than 2 cm wide;

2.5.12.6.8. buds and sprouts;

2.5.12.6.9. leaves and needles.

2.5.12.7. If there is more than one type of damage to the tree, the damage which is the closest to the root collar shall be recorded.

2.5.12.8. New tree damages which have not been recorded in the previous time of measuring shall be recorded during re-measuring of sample plots.

2.6. Measuring of static death rate (fallen deadwood)

2.6.1. In measuring death rate, the species, position (stub or lying deadwood) and diameter at the thin-end and butt-end shall be determined.

2.6.2. If a bole length with a stump has remained for fallen deadwood, the diameter of the butt-end shall be measured in the distance of 1,3 m from the root collar, assuming that the diameter of the thin-end is 1 cm.

2.6.3. If the fallen deadwood is a broken top, the diameter of the butt-end shall be measured at the breaking point, assuming that the diameter of the thin-end is 1 cm.

2.6.4. If the fallen deadwood is a bole shiver, diameters shall be measured at both ends of the fallen deadwood.

2.6.5. The diameter of stubs shall be measured in height of 1,3 m and at the end of the stub. If a tree part (fallen deadwood) that has separated from the stub is visible, it shall be assumed that the diameter of the thin-end of the stub is the diameter of the butt-end of such fallen deadwood.

2.6.6. If the stub is less than 1,3 m long, the butt-end of the stub shall be measured at the root collar.

2.6.7. If direct measuring of the thin-end of the stub is not possible, it shall be determined by the height of the stub, assuming that the diameter of the thin-end of the stub is the same as the height of the stub.

2.6.8. Freshly prepared assortments, wood at delivery roads, sown tree stumps, as well as stumps of broken trees less than 0,5 m short shall not be included in death rate.

2.6.9. Such fallen deadwood shall be measured, which are more than 6,1 cm wide at the butt-end. The belonging of the fallen deadwood to the sample plot A or B shall be determined according to the location of the fallen deadwood in the sample plot.

2.6.10. If the butt-end of the fallen deadwood is located in a sample plot, the length of the whole fallen deadwood shall be measured also if part of the fallen deadwood is located outside the sample plot.

2.6.11. If the butt-end of the fallen deadwood is located outside the sample plot, the

fallen deadwood shall not be measured.

2.6.12. Death rate shall be classified according to its quality groups:

2.6.12.1. fresh death (until the bark of the bole begins to peal);

2.6.12.2. death of average age (from the time when bark of the bole begins to peal until epiphytes begin to occur on less than 10 % of the cover of the visible surface of the bole);

2.6.12.3. pieces of rotten wood (cover of epiphytes is more than 10 % of the visible surface of the bole).

2.6.13. All types of death rate shall be measured at odd times of surveying sample plots. Only such death rate shall be surveyed at even survey times, which has occurred after the previous measuring.

2.7. Description of changes of growing trees in cycles of re-measuring

2.7.1. The belonging of a tree to the following groups of changes of growing trees surveyed during the previous measuring shall be recorded in cycles of re-measuring (if applicable):

2.7.1.1. the tree has been cut down and taken away (or logging is taking place at the time of surveying);

2.7.1.2. the tree has been cut down and left in the forest;

2.7.1.3. the tree has fallen in windfall and taken away;

2.7.1.4. the tree is standing and dead;

2.7.1.5. the tree has fallen in windfall;

2.7.1.6. the tree is broken and forms a stub;

2.7.1.7. the top of the tree has been broken;

2.7.1.8. the tree has been gnawed off by a beaver.

2.7.2. The wood volume of any the above mentioned tree group shall be determined as the living tree volume calculated in the previous cycle of surveying. The sum of tree volumes belonging to each group in a sample plot shall form the stock corresponding to each group. The annual death rate and the fallen amount shall be determined by diving the total amount of the group by the number of years of the cycle of surveying.

2.8. Data registration and storage

2.8.1. The data obtained as a result of surveying sample plots initially shall be registered in work tables or their equivalents on the field computer.

2.8.2. Data of the monitoring of forest resources shall be copied from field computers to the data base not less than once in two weeks.

2.8.3. Logical control of data shall be performed and the data errors detected shall be returned to the field working group for correction in order to take repeated measurements in the sample plot.

2.8.4. Data obtained in surveying of sample plots for each year of the monitoring of forest resources and a full cycle of five years shall be permanently stored in

the form of data base, ensuring a possibility to analyse the information in historical development. Permanent data bases shall ensure a possibility to supplement them with new indicators to be determined at any time.

2.8.5. The information compiled during preparation work and cartographic materials shall be stored in printed form until the next survey when they are updated with as new data as possible.

CALCULATIONS OF PARAMETERS OF MONITORING ELEMENTS

3. Methodology for Calculation

3.1. Determination of division of the area according to the types of land use and the categories of forest land

3.1.1. Division of the area according to the types of land use initially shall be determined after the first level of selecting sample plots where the type of land use shall be determined at points located at every m according to orthophoto maps or satellite images in accordance with the types of land use determined in the State.

3.1.2. The total area of forest land according to the annual sample plot survey data shall be determined as follows:

$Qm=Q^{*}pm$ or (4)

$Qm=Km^{*}qR$ (5)

$Qm=(qm^{*}qR)/500$, where (6)

Q – the total territory of Latvia;

Qm – the areas of forest land;

pm – proportion of forest land.

$Pm=Km/K$, where (7)

Km – sum of the sample plot or its parts, which are included in the forest land and have been itemised, in units;

K – the total number of sample plots in the State.

$K= Q/qR$, where (8)

qR – the area represented by one sample plot;

qm – the area of all sample plots and sectors falling into forest land.

3.1.3. The area assessment error in percentage shall be calculated:

$PQm=((1-pm)/((kK-1)^{*}pm))^{*}100$ (9)

3.2. General principles for the calculation of the indicators of wood resources in sample plots

3.2.1. In each sample plot or sample plot sector the indicators of wood resources shall be calculated differently for each forest element, considering the smallest cluster of trees of the stand, for which the values of taxation indicators are determined, as the forest element. It is the part of a stand, which consists of one level, advanced growth and trees of species.

3.2.2. Values of additive taxation indicators at the stand level shall be obtained as the relevant sums. Indicators that depend on the area shall be expressed per 1 ha.

3.3. Determination of the number of trees

3.3.1. Number of the forest element trees Ni:

$$N_i = \frac{n_i}{m}$$, i=1,2...,l , where (10)

Ni – number of the forest element trees, ha

l – number of the relevant forest elements (species of trees);

ni – number of trees in the sample plot in i-th forest element;

m – recalculation coefficient of the sample plot concentric circle (concentric circle Am = 0,0025, concentric circle Bm =0,01, concentric circle Cm = 0,05).

3.3.2. Number of trees of a stand (level of a tree stand) N, ha^{-1}:

$$N = \sum_i N_i$$, i=1,2...,l (11)

3.4. Determination of the basal area of the stand

3.4.1. Basal area of the forest element Gi:

$$G_i = \frac{\pi}{40000m} \sum_j d_j^2$$, j=1,2...,ni , where (12)

Gi – basal area of the forest element, $m^2 * ha^{-1}$

dj – diameter in height of 1,3 m, cm.

3.4.2. Basal area of the stand (level of the tree stand) G, $m^2 * h\text{-}1$

$$G = \sum G_i$$, i=1,...,l (13)

3.5. diameter in height of m

3.5.1. Diameter of the forest element in height of 1,3m Di, cm:

$$D_i = 100\sqrt{\frac{4G_i}{\pi \cdot N_i}}$$ (14)

3.6. Average height

3.6.1. Average height of the forest element Hi, m:

3.6.1.1. if the number of inventory trees of the forest element nu is less than 5, its average height shall be calculated as the arithmetic mean:

$$H_i = \frac{\sum_j h_j}{n_i}$$, i=1,...,l, where (15)

hj – height of the tree, m

3.6.2. if the number of inventory trees of the forest element nu is more than 5, the height shall be calculated for each tree according to the measurements of inventory trees: heights shall be calculated for each of trees according to the measuring of the inventory trees performed:

Table 1: Output Information for Determination of Parameters of the Contour Line Equation

Diameters, cm	D1	D2	. . .	Dk
Height of trees, m	H1	H2	. . .	Hk

3.6.3. an equilateral hyperbola arc with the following equation shall be used for levelling of heights:

$$H = H_0 + \frac{D}{K \cdot D + C} \quad (16)$$

where H0 – 1,3 m.

3.6.4. the parameters of the contour line equation shall be found using formulas (20) and (21):

$$C = \frac{N \cdot \sum \frac{1}{D_i \cdot (H_i - 1{,}3)} - \sum \frac{1}{D_i} \cdot \sum \frac{1}{H_i - 1{,}3}}{N \cdot \sum \frac{1}{D_i^2} - \sum \frac{1}{D_i} \cdot \sum \frac{1}{D_i}} \quad (17)$$

$$K = \frac{\sum \frac{1}{H_i - 1{,}3} - C \cdot \sum \frac{1}{D_i}}{N} \quad (18)$$

3.6.5. after determination of the contour line height of each D1,3 m tree is known.

3.7. Stock of the tree stand

3.7.1. Stock of the forest element Mi, $m^3 * ha^{-1}$

$$M_i = \frac{1}{m} \sum_j v_j \quad \text{, j=1,2...,l, where} \quad (19)$$

vj – volume of the tree bole, m^3

$$v_j = \psi \cdot h_j^{\alpha} \cdot d_j^{\beta \cdot \lg h_j + \varphi} \quad \text{, where} \quad (20)$$

hj – height, m;

dj – diameter in height of 1,3 m, cm;

Ψ, α, β, φ – volume coefficients of the bole which depend on the species of the tree (Table 2)

Table 2: Values of Volume Coefficients of the Bole

Tree species	Ψ	α	β	φ
Pine	$1{,}6541*10^{-4}$	0,56582	0,25924	1,59689
Spruce	$2{,}3106*10^{-4}$	0,78193	0,34175	1,18811
Birch	$0{,}9090*10^{-4}$	0,71677	0,16692	1,75701
Aspen	$0{,}5020*10^{-4}$	0,92625	0,02221	1,95538
Black alder	$0{,}7950*10^{-4}$	0,77095	0,13505	1,80715

Tree species	Ψ	α	β	φ
Grey alder	$0{,}7450*10^{-4}$	0,81295	0,06935	1,85346
Oak	$1{,}3818*10^{-4}$	0,56512	0,14732	1,81336
Ash	$0{,}8530*10^{-4}$	0,73077	0,06820	1,91124

3.7.2. Stock of the stand M, $m^3 * ha^{-1}$

$$M = \sum_i M_i \quad \text{, i=1,2...,l} \qquad (21)$$

3.7.3. Stock of snags Ms, $m^3 * ha^{-1}$ shall be calculated using the formulas (22), (23) and (24).

3.7.4. Stock of fallen deadwood Mk, $m^3 * ha^{-1}$ shall be calculated:

3.7.4.1. if the length of the trunk has remained for a fallen deadwood and it altogether is located within the borders of the concentric circle, its volume shall be calculated using the formulas (23) and (25):

$$M_{k1} = \frac{1}{m}\sum_j v_j \quad \text{, j=1,2...,n where} \qquad (22)$$

n– the number of trees corresponding to Paragraph 154.1

3.7.4.2. if the fallen deadwood is a shiver of a tree or a part in the concentric circle of a torn-up tree, its volume shall be calculated according to the simple centre plot formula of F. Huber:

$$v_j = \frac{\pi \cdot d_{l/2}^2}{4} L \quad \text{, where} \qquad (23)$$

vj – volume of the fallen deadwood, m^3

L – length of the part in the concentric circle of the fallen deadwood, m;

$d_{l/2}^2$ – diameter at the middle of the fallen deadwood, m.

$$M_{k2} = \frac{1}{m}\sum_j v_j \quad \text{, j=...,nk2, where} \qquad (24)$$

nk2 – number of the trees corresponding to Paragraph 154.2

3.7.4.3. Total stock of the fallen deadwood Mk, $m^3 * ha^{-1}$

$$M_k = M_{k1} + M_{k2} \qquad (25)$$

3.7.5. Stock of stubs Mst, $m^3 * ha^{-1}$

$$v_{st} = \frac{\pi \cdot d_{l/2}^2}{4} h_{st} \quad \text{, where} \qquad (26)$$

v_{st}, m^3 – volume of an individual stub;

$d_{1/2}$ – diameter at the middle of the stub (to be measured directly), m;

h_{st} – height of the stub, m.

$$M_{st} = \frac{1}{m}\sum_{j} v_{stj} \quad , j=1,2...,n_{st}, \qquad (27)$$

3.8. Biomass of the tree crowns

3.8.1. Biomass of the tree crowns shall be calculated according to the volume of the tree bole (Table 3):

Table 3: Biomass of the Tree Crowns According to the Volume of the Tree Bole

Height of trees, m	Biomass of the tree crown (t) per 1 m³ of the bole volume		
	for pine	for spruce	for deciduous trees
6	0.15	0.47	0.18
8	0.12	0.38	0.15
10	0.10	0.31	0.13
12	0.08	0.26	0.11
14	0.07	0.22	0.09
16	0.06	0.18	0.08
18	0.05	0.15	0.07
20	0.04	0.13	0.06
22	0.04	0.11	0.05
24	0.03	0.10	0.04
26	0.03	0.09	0.04
28	0.02	0.08	0.03
30	0.02	0.07	0.03

3.9. Actual current increment of the stock

3.9.1. Actual current increment of the stock ZMi shall be calculated, using the formula (:

$$Z_M = 12732{,}4\psi G H^{\alpha} D^{\beta \lg H + \varphi - 2}\left[\frac{Z_H(\alpha + \beta \lg D)}{H} + \frac{Z_D(\varphi + \beta \lg H)}{10D}\right] \quad , \text{ where} \qquad (28)$$

ZMi – actual current periodical increment of the stock on average, m³ * h-1 * g-1

G – basal area of the forest element in height of 1,3 m, m² * ha⁻¹

H – the average height of the forest element, m;

D – the average diameter of the forest element in height of 1,3 m, cm;

ZD – the increment in diameter of the relevant lustrum of the forest element, mm:

ZD = 2iu , where (29)

i – the average width of the relevant lustrum growth ring of the forest element, mm;

u – coefficient of the thickness of the bark (Table 4);

ZH – the increment in height of the relevant lustrum of the forest element, mm:

$$Z_H = \frac{2iH(aD+b)}{cD+100}$$, where (30)

a,b,c – coefficients of the course of growth in height.

Table 4: Values of Empirical Coefficients

Tree species	Increment in height			Bark volume			u
	a	b	c	p	q	w	
P	–0.0642	6.356	27.105	20.6	143.9	19.53	1.103
S	–0.0256	1.693	5.794	5.25	117.6	5	1.046
B	–0.0728	–1.51	–35.71	0.2	110.2	0.02	1.095
A	–0.0357	2.352	12.829	0.78	109.9	0.67	1.061
BA	0.005	7.24	90.909	–0.55	119	–0.36	1.081
GA	0.0958	3.478	45.988	–49.1	93.3	–45.83	1.05
O	–0.0728	–1.51	–35.71	0.2	110.2	0.02	1.095
As	–0.0728	–1.51	–35.71	0.2	110.2	0.02	1.095

in stands which have not reached cm in diameter, the annual increment shall be calculated as general quantity on the whole level of the stand according to the formula:

ZMn=((MA*n)/A) , where (31)

MA – current stock of the stand, ($m^3 * ha^{-1}$);

A – age in years;

n – time period (years).

3.9.2. Actual current increment of the stand ZM, $m^3 * ha^{-1} * g\text{-}1$

$$Z_M = \sum_i Z_{Mi}$$,i=1,2...,l (32)

3.10. . Mass of the stock and current increment of the stock

3.10.1. Values of the above mentioned categories of the stock and current increment of the stock shall be expressed in mass units (t) multiplied by recalculation coefficient km ($t * m^3$).

3.10.2. The following values of the coefficient km have been determined in the Latvian State Standard LVS 82 1997: for pine and aspen – 0,81, for spruce – 0,73, for birch – 0,94.

3.11. Assessment of the wood

3.11.1. Values of the above mentioned categories of the stock and current increment of the stock shall be calculated including bark. Values of the relevant part of the wood shall be obtained dividing them by the bark volume coefficient s:

$$s = \frac{pd_j + q}{wd_j + 100}$$, where (33)

p,q,w – bark volume coefficient (Table 5).

3.12. Assessment of bark

3.12.1. Values of the bark of the abovementioned categories of the stock and current increment of the stock shall be calculated as differences, deducting values of the relevant part of the wood from the stock or its increment.

3.13. . Evaluation of stand parameters and their variation per unit of area

3.13.1. Taking into account that the size of the basic sample plot in the monitoring of forest resources is 500 m², but it is divided into smaller sample plots and sectors with different dimensions, the calculation method of average weighted values shall be used in evaluating the average indicators and their variation. Indicators of the stand per 1 ha shall be calculated as follows:

$$\ddot{Y} = \sum(Y_i * p_i) / \sum p_i \quad \text{, where dispersion} \quad (34)$$

$$\sigma(\tilde{Y})^2 = \sum((Y_i - \ddot{Y})^2 * p_i) / \sum p_i \quad \text{, where} \quad (35)$$

Yi – value of the parameter of the stand per 1 ha in i-th sample plot unit

$$Yi = yi/xi \quad \text{, where} \quad (36)$$

yi – value of the parameter in i-th sample plot unit;

xi – area of the sample plot unit, m²;

Ÿ – average indicator of the stand per 1 ha;

pi – part of the sample plot.

$$pi = xi/q \quad \text{, where} \quad (37)$$

area of the sample plot (0,05 ha).

3.13.2. The average indicator per 1 ha dispersion shall be determined as follows:

$$\sigma(\ddot{Y})^2 = \sigma(\tilde{Y})^2 / n \quad (38)$$

3.13.3. Standard deviation of average indicators in absolute values:

$$\sigma(\ddot{Y}) = (\sigma(\ddot{Y})^2)^{1/2} \quad (39)$$

and percentage:

$$P_{\ddot{Y}} = ((\sigma(\ddot{Y}))/ \ddot{Y}) * 100 \quad \text{, where} \quad (40)$$

σ(Ỹ)2 – dispersion of the parameter of the stand per 1 ha;

n – number of units of sample plots (sample plots, sectors).

3.14. . Evaluation of indicators of the monitoring of forest resources in the object of inventory

3.14.1. The tree stand, increment and their number in the whole object of monitoring shall be calculated multiplying the values of such indicators per 1 ha by the number of corresponding stand groups (strata):

$$Y_i = \ddot{Y}_i * Q_i \quad \text{, where} \quad (41)$$

Ÿi – value of the inventory indicator of a stand group;

Qi – area of the i-th stand group, ha.

3.14.2. An error of a tree stock and their number in the whole area shall be determined according to the formula:

$$P_{Ti} = (P(\ddot{Y}i)^2 + (P_{(Qi)}{}^2)^{1/2}$$, where (42)

P(Ÿi) – error of the monitored indicators of the i-th stand group (%);

P(Qi) – error of the area of the i-th stand group (%).

3.14.3. The increment balance for a group of stands in an object of inventory shall be evaluated combining the whole stock of sample plots of such group and including the trees cut down between the monitoring of forest resources.

3.15. Determination of age of a forest element

3.15.1. Age of a forest element shall be determined according to the formula:

$$Af = (Am + Ai)$$, where (43)

Af – actual age of the forest element (years);

Am – the age of trees determined in the forest at height of 1,3 m (years);

Ai – correction of the actual age (Table 5).

Table 5: Correction of Actual Age of the Forest Element

Tree species	Correction (years)
Coniferous trees	7
Oak, flattering elm, elm	5
Birch, black alder, ash, linden, maple	3
Aspen, poplar, grey alder	2

CLASSIFIERS TO BE USED IN THE MONITORING OF FOREST RESOURCES

1. Types of sample plots

Type of the sample plot	Code
Permanent sample plots	1

2. Accessibility of the centre of sample plots

Centre of the sample plot	Code
Accessible	1
Not accessible	2

3. Forms of property

Name of the form of property	Code
Public forests:	
State	1
Other public authorities (local governments)	2
Private forests:	
Private individuals	3
Undertakings	4
Other private institutions	5

4. Categories of forest land and other land

Name	Code
Forest	10
Stunted stand	11
Burn	12
Windfalls	13
Felled area	14
Marshes	
Moss marsh	21
Herbaceous marsh	22
Transitional swamp	23

Name	Code
Glade	30
Glade	31
Glade for feeding forest animals	32
Heath	33
Sands	34
Overflowing clearing	40
Land under forest infrastructure objects	
Forest road	51
Clearance	52
Block ride	521
Mineralised strip	522
Forest ditch	53
Forest channel	531
Ditch route	532
Other objects of the forest infrastructure	
Seed plantations	541
Recovered land	542
Forest water reservoir	543
Recreational area	544
Other land of special significance	545
Land outside the forest land	
Arable land	60
Grassland	61
Forest in agricultural land (number of trees > units/ha	62
River	63
Overgrown agricultural land (bushes or trees < units/ha	64
Lake, pond	65
Agricultural ditch	66

Name	Code
Motor road with a belt	67
Railway with a belt	68
Overgrown quarry	69
Fresh quarry	70
Alluvial land of a river	71
Yard (household plot)	72
Towns, villages	73
Industrial routes (electricity, gas, oil, etc.)	74

5. Origin of the stand

Type of origin	Code
Naturally from seed	11
Naturally from sprouts	12
Anthropogenic (by sowing or planting)	20

6. Types of forest

Name	Code
1. Dry forests	
Cladinoso Callunosa	1
Vacciniosa	2
Myrtillosa	3
Hylocomiosa	4
Oxalidosa	5
Aegopodiosa	6
2. Wet forests	
Callunoso-sphagnosa	7
Vaccinioso-sphagnosa	8
Myrtilloso-sphagnosa	9
Myrtilloso politichosa	10
Dryopteriosa	11

3. Marsh forests	
Sphagnosa	12
Caricoso-phragmitosa	14
Dryopterioso-caricosa	15
Filipendulosa	16
4. Dry mineral forests	
Callunosa mel.	17
Vacciniosa mel.	18
Myrtillosa mel.	19
Mer curaliosa turf. mel.	21
5. Turf forests	
Callunosa turf. mel.	22
Vacciniosa turf. mel.	23
Myrtillosa turf. mel.	24
Oxalidosa turf. mel.	25

7. Division of trees in Kraft Classes

Name	Code
Kraft Class I	1
Kraft Class II	2
Kraft Class III	3
Kraft Class IV	4
Kraft Class V	5

8. Belonging of Tress to a Stand Level

Name	Code
1st level tree	1
2nd level tree	2
3rd level tree	3

9. Tree species

Name	Code
Pine	1
Spruce	3
Birch	4
Black alder	6
Aspen	8
Grey alder	9
Oak (common)	10
Ash	11
Linden	12
Larch	13
Other pines (Jack pine, Weymouth pine)	14
Other spruces (white spruce, Douglas fir)	15
Elm, flattering elm	16
Beech	17
Hornbeam	18
Poplar	19
Willow	20
Goat willow	21
Cedar	22
White fir	23
Maple	24
Crabapple	51
Cherry	56

10. Bush species

Name	Code
Osier	30
Junipers	31
Rowan-trees	32

Name	Code
Buckthorns	33
Hazel-trees	34
Bird-cherries	35
Honeysuckles	36
Viburnums	37
Spindle-trees	38
Ribes sp.	39
Currants	40
Hawthorns	41
Jasmines	42
Elders	43
Spiraea	44
Lilacs	45
Cotoneasters	46
Barberries	47
Dogwood	48
Rosa sp.	49
Siberian peashrub	50
Coniferous trees	52
Deciduous tree	53
Unidentifiable species	54
Mezereon	55
Common buckthorn	30

11. Damages

Name	Code
Windthrows, windfalls, snow-breaks, snow crushes	10
Water	20
Wildlife	30

Fire	40
Diseases	50
Insects	60
Others	70

12. Damaged place

Name	Code
Roots and stumps up to 30 cm above the root collar	1
Lower part of the bole from stump up to the first green branch	2
Whole bole from the height of the stump up to the top	3
Upper part of the bole from the first green branch up to the top	4
Top	5
Branches in the living crown	6
Branches which have grown out of the bole and are more than 2 cm wide	7
Buds and sprouts	8
Leaves and needles	9

13. Placement of fallen deadwood

Name	Code
Lying fallen deadwood	none
Stub	2

14. Death rate quality groups

Name	Code
Fresh	1
Old (epiphytes cover >% of the surface)	2
Rotten wood	3
Living stub	4

15. Group of changes in trees in re-measuring of the sample plot

Name	Code
Tree has been cut down and taken away (or logging is taking place at the time of surveying)	1
Tree has been cut down and left in the forest	2

Name	Code
Tree has fallen in windfall and taken away	3
Tree is standing and dead (snag)	4
Tree has fallen in windfall	5
Tree is broken and forms a stub	6
The top of the tree has been broken	7
The tree has been gnawed off by a beaver	8

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