Romania-Ukraine
ENI-CROSS BORDER COOPERATION

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RESFOR Field Protocol
Forest - inventory

Version 3.0
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A project implemented by the partnership between WWF Romania - Danube Carpathian Programme, Maramures Branch, and "Stefan cel Mare University" of Suceava in Romania, the Ukrainian Research Institute of Mountain Forestry named after P.S. Pasternak and Ecosphera in Ukraine.

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1 Introduction

The Project ”Promote deadwood for resilient forests in the Romanian-Ukrainian cross-border region (RESFOR)” is a trans-boundary research project in the forestry domain, particularly on the issue of deadwood, as an important element: 1) in securing forests productivity, the biodiversity of forest ecosystems, and ecosystem services valuable for local communities; and, 2) in improving forests resilience to climate change.
The Field Protocol is elaborated under **Activity A3.4 - Conduct desktop (state of the art) and field research (including experimental research in pilot area)** for highlighting deadwood importance and developing innovative best practice management solutions designed to increase the forest ecosystems long term productivity as well as their biodiversity and resilience to climate changes. The Field Protocol contributes to the achievement of **Deliverable D3.4.2 - Harmonized methodology for inventory of deadwood in the field** (determining the most suitable instruments, dendroecological techniques, dendrochronological investigations, ecological indexes and parameters (biometric and phenotypic characteristics eg. dbh, total height, position, crown diameter, crown length, etc), determination of deadwood decay degree).
The Field Protocol integrates feedback and input from Project Partners as well as from members of the NRE – Network of Researchers and Experts.

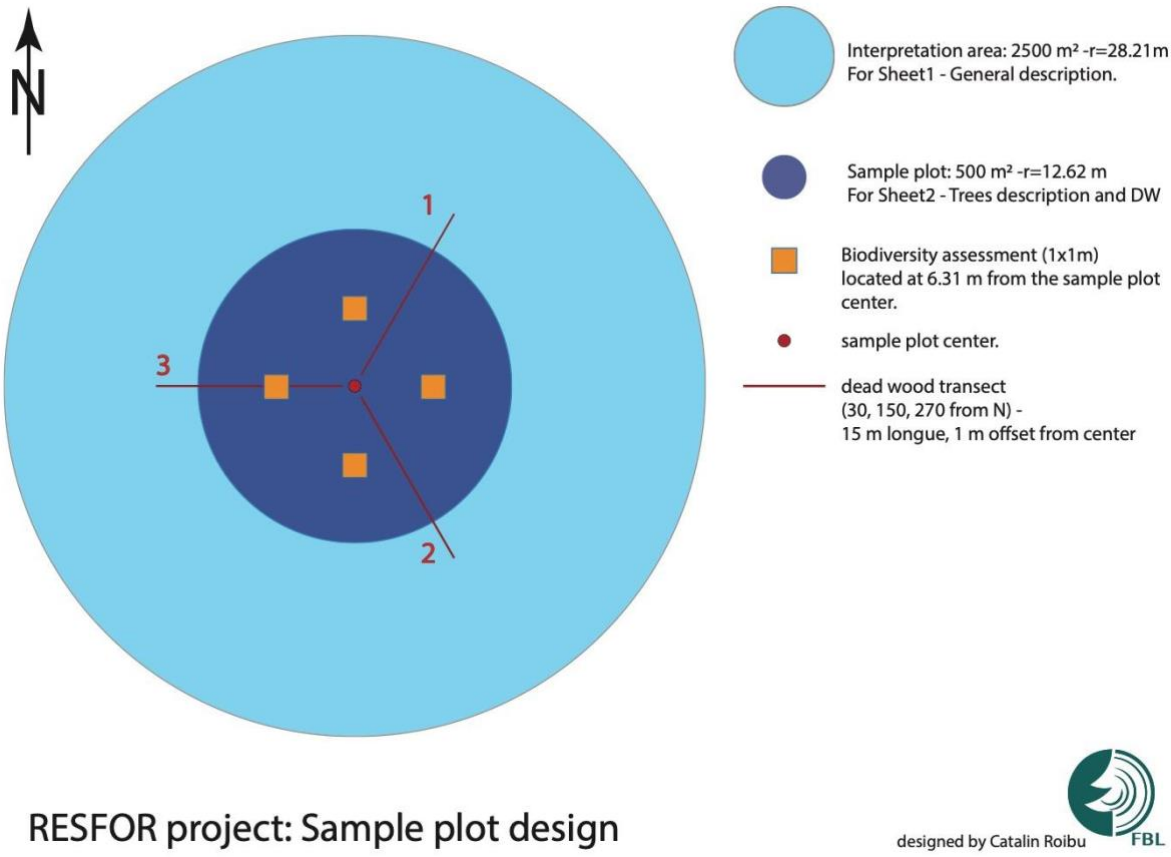
With the so-called **deadwood inventory,** the RESFOR project would like to obtain for the first time, representative data on the structure and dynamics of primeval (unmanaged) forests by generalizing the knowledge gained from small, intensively observed monitoring plots to a larger area of primeval forest. Data from primeval forests are extremely valuable reference values for comparisons with managed forests and natural forest reserves in Europe and form an important basis for reviewing and refining nature conservation and silvicultural concepts and approaches.

The inventory aims at gathering the following data:
• general stand data such as stem number, basal area, stock, diameter distribution and tree species composition and their change;
• volume and decomposition stage of standing and lying deadwood;
• frequency (density) of trees with habitat structures (structural features that are particularly valuable for biodiversity);
• information on stand structure (vertical structure, stand density).

In addition to the stand data described above, the RESFOR project is also particularly interested in characteristics that give indications of natural disturbances, their extent and influence on forest development. Questions arise about the size of disturbances in these ecosystems and the associated regeneration processes. Last but not least, the RESFOR project will collect information about the importance of the dead wood on forest resilience in the context of climate changes.

The **Field Protocol** describes the procedure for collecting data for the inventory both in Romania and Ukraine and serves as a guide for the recording groups in both countries represented by USV and respectively by UkrRIMF team of experts. The Field Protocol sets the standard for surveys on sampling plots in primeval (unmanaged) forests (1 in RO and 1 in UA) vs managed forests (1 in RO and 1 in UA), and must be strictly adhered to, even if difficulties should arise. Difficulties and problems in the application of the Field Protocol must be recorded separately and discussed with the inventory supervisors. It is the responsibility of the recording groups in both countries to ensure that the recording instructions are observed and that the data supplied is correct.

The Field Protocol is structured according to the field recording workflow. It contains the definitions of the forest characteristics for which data will be collected as well as the recording rules. The unit of measurement and the measuring range are given in square brackets. The procedure and reasons that led to the inclusion of a characteristic are described as well.
The Field Protocol is designed for gathering data using GPS, Compass, Vertex, measuring tape and gradiometer, using tablets and the FieldMap application software.



Sheet 1. General description

(plot name- code (4 letters),
Location (GPS coordinates, forest district, forest management unit (FMU), compartment)
Date
Team members and Field coordinator
Sample plot shape: Considering the project necessities, we will use a network of circular plots (500 m^2) randomly set (20 plots for both unmanaged and managed forests).

Site topographical description: slope, aspect, geomorphology unit (ridge, slope, plateau, etc.)
Stand basic description: structure (primeval, old-growth, managed uneven aged, managed even aged), storied, main composition, canopy cover (1.0, 0.7-0.9, 0.4-0.6, 0.1-0.3), stand origin.
Litter
Humidity
Basic information regarding disturbance history (trace of human activity for the natural forest)

Sheet 2 Sample tree assessment (STA)

The aim of the Sample Tree assessment is to obtain information on the status and condition of the sample trees. The sample tree assessment includes the following measurements and speeches:

1. assessment of tree species and dimensions.

2. assessment of features that give an indication of the origin of the tree and its competitive situation

3. assessment of characteristics that are important for biodiversity (habitat structures).

All sample trees are mapped from the PC with azimuth, horizontal distance using the FieldMap system, so that they can be unambiguously identified again in a subsequent inventory. For this the tripod/monopod with the compass (True Pulse compass or equivalent) is placed over the oak/metal pile, which marks the PC (the lead of the tripod must hang exactly over the pile center or the O-profile.

Sample trees include All **living and dead, standing and lying** Trees and shrubs ≥ 6 cm DBH, whose center at 1.3 m height lies within the 500 m^2 circle. A tree is considered standing if the stem axis deviates less than 45^o from the vertical and the stem is still connected to the rootstock.

STA 201 Sample tree number

Each tree will assign a sequential number. This number uniquely identifies the tree (white paint or plastic or PVC numbers).

STA 202 Azimuth [deg]

The azimuth of the left tree edge at a height of 1.3 m seen from the PC is given for each sample tree. This feature will be automatically recorded by the FiedMap. Non-measurable azimuths (e.g. if the measuring point is covered by another tree in the line of sight) are estimated.

STA 203 Horizontal distance [m]

The distance is the slope distance from the centre of the sample area to the center of the tree (center of cross section), measured at 1.3 m above the ground (height of the BHD measuring point). The measurement (in m to the nearest cm) is made using the TruPulse (see short instructions for the instruments). For this purpose, the reflector is positioned at a set measuring height (1.70-1.80m) at the left tree edge seen from the PC and aimed at from the center with the TruePulse. (If necessary, the reflector for the distance measurement can also be held against the right tree edge; for the measurement of the azimuth, however, the left tree edge must be aimed at). For these measurements it is necessary to use a foliage filter.

For trees at the boundary of the sample plot, the distance must be measured to the nearest cm (to the middle of the tree) using a measuring tape in order to be sure whether the tree needs to be included.

STA 204 Inclination PC - tree [%]

Together with distance and azimuth, inclination allows the exact positioning of the tree based on the measured PC coordinates. The inclination is measured parallel to the slope distance measurement from the PC to the middle of the tree. The sign (+/-) is indicated.

STA 202, 203 and 204 are automatically recorded by the FieldMap system.

STA 205 Species

The species must be indicated for all sample trees. The codes of the tree and shrub species (three digits code) are listed in the appendix B. If the species cannot be identified, only the genus name (code) is indicated. For dead trees / trunks the species must be determined as accurately as possible. If the genus can no longer be determined due to strong decomposition, note 390 (= coniferous wood) or 800 (= deciduous wood) or, if this is also not recognizable, 999 (cannot be determined).

STA 206 Tree status

The **tree status** determines which characteristics are assessed on a sample tree. It also gives an indication of whether a tree has been thrown by the wind or is standing dead and/or broken.

Code	Explanation
11	Living tree, standing (a tree is considered to be living as long as there is at least one green branch).
15	Living tree, lying (tree crown lies on the ground).
35	Dead lying tree. Entire tree with root plate and crown.
36	Dead entire standing tree with crown (branches with a diameter ≤ 3 cm still present).
37	Dead entire standing trunk, (on broadleaved trees, main branches >3 cm or branch stubs still present).
38	Standing part of trunk ≥ 1.3 m (DBH measurement possible) -snag
39	Dead standing stub, 0.50 - 1.29 m

A dead tree/trunk is considered standing as long as the stem axis deviates less than 50^{o} from the vertical and is still connected to the rootstock.

STA 207 Measuring method DBH

In those cases where neither the clip nor the circumference tape can be used for proper measurement, the BHD is estimated at the prescribed measuring point. Possible BHD measuring devices are:

1. Calliper (DBH ≤ 80 cm)
2. Diameter measuring tape (DBH > 80 cm)
3. Estimation with aids (Scale, Ranging rod etc.)

STA 208 DBH [cm]

The diameter of the sample tree is measured at a height of 1.3 m (Diameter at Breast Height (DBH) (Diameter at 1.3 m) and given in one decimal. Example DBH measured: 7.7 cm. The **calliper threshold** is **6 cm**. The measuring range of the calliper ranges from 6 cm to 80 cm. Larger diameters are measured with the diameter measuring tape.

Remarks on the measurement of the DBH (Figure 2.1):

- The calliper rule must always point at the SPC.
- On slopes, dbh is measured on the uphill side of the sample tree.
- With tilted trees, the caliper must be positioned orthogonal to the stem axis.
- If the stem is forked at a height of more than 1.3 m, then the tree must be measured as one sample tree, but specified as 'forked" tree.
- If the stem is forked at a height of less than 1.3 m, then each part has to be treated as an individual sample tree.
- If a regular measurement with a caliper is not possible, e.g. if dbh > 80 cm or if the parts of a forked tree have grown together, the field team measures the circumference.
- For the determination of the BHD, the root base is decisive, even if it is not on the ground (stilt roots).
- For lying trees, the breast height is determined at a distance of 1.3 m from the root base and DBH is measured at orthogonal angle to the stem axis.
- If a sample tree is forked at exactly 1.3 m, then the dbh measuring point must be chosen at a lower height and only the circumference is measured.

The measuring position is indicated with a 5 cm long line on the tree at the point where the calliper rule touches the tree using with paint (T). As these markings are not permanent, the measuring height of 1.3 m has to be stictly adhered to (e.g., mark 1.3 m on your shirt).

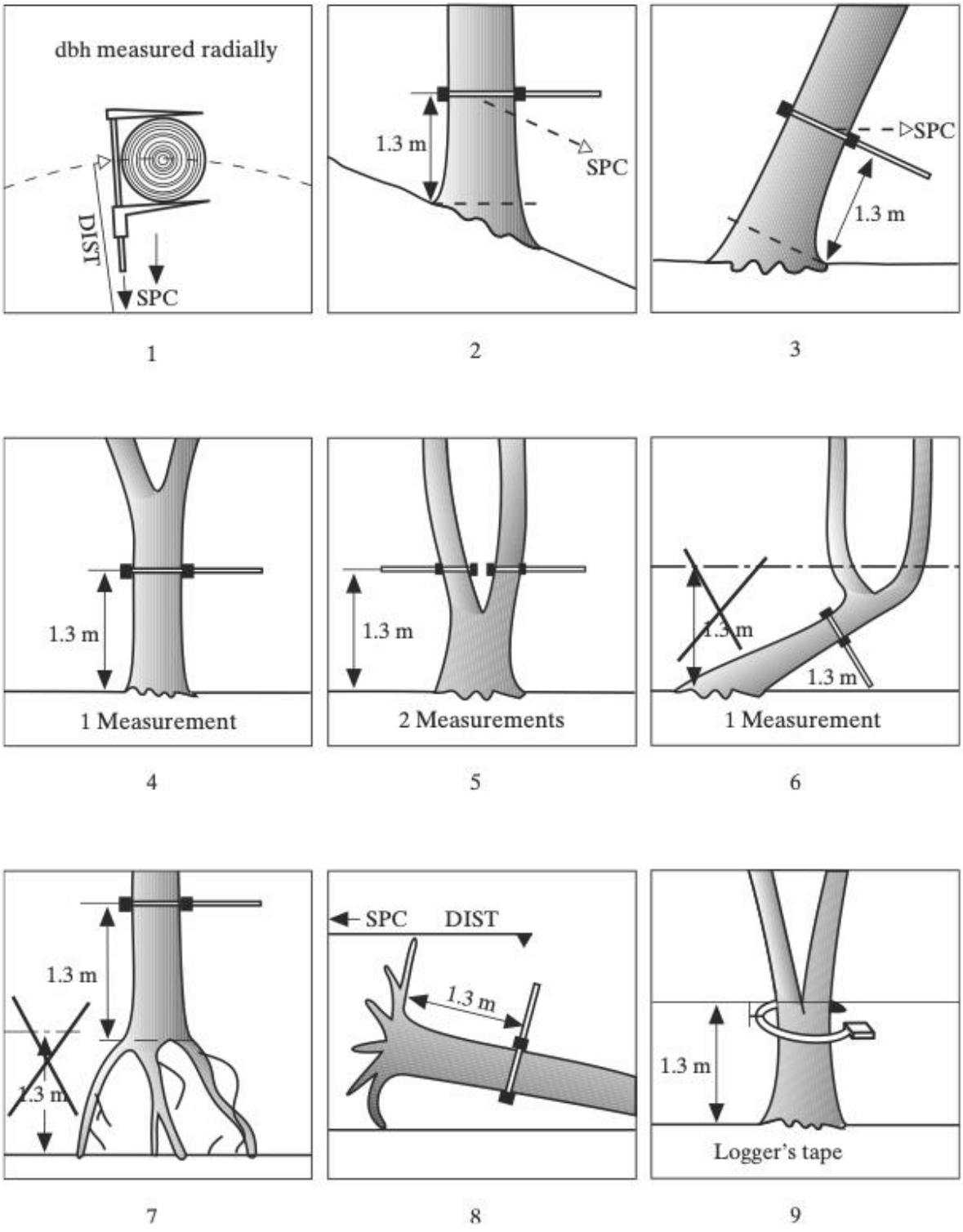


Figure 2.1: Determination of DBH

STA 209 Tree height [m]

The vertex and a transponder are used for tree height measurement. *Caution: Calibrate Vertex daily before starting work! See instructions for devices.*

Procedure: One person holds the transponder on the tariff tree at a height of 1.3 m, vertically under the tree top, the other person looks for a place from which one has a more or less clear view of both the highest shoots of the tree crown and the transponder. Then first using the vertex to locate the transponder and then the tree top (at the highest shoot of the tree) and read the height. The difference between apparent and effective height must be taken into account (Figure 2.2). On slopes, tree heights are best measured parallel to the contour line. The height is given with an accuracy of 0.1 m.

Figure 2.2: Error source during tree height measurement

STA 210 Height of crown[m]

The height of the green crown is defined by the lower limit of the crown. The crown attachment is considered to be the attachment point of the lowest green branches on the trunk, whereby epicormic branches and the lowest, often sparsely leaved and slowly dying branches are not taken into account (Figure 2.3). Epicormic branches belong to the crown if they are about the same thickness as the surrounding branches of the main crown and are integrated into the crown silhouette. The measurement of the crown height is analogous to the tree height measurement with vertex and transponder.

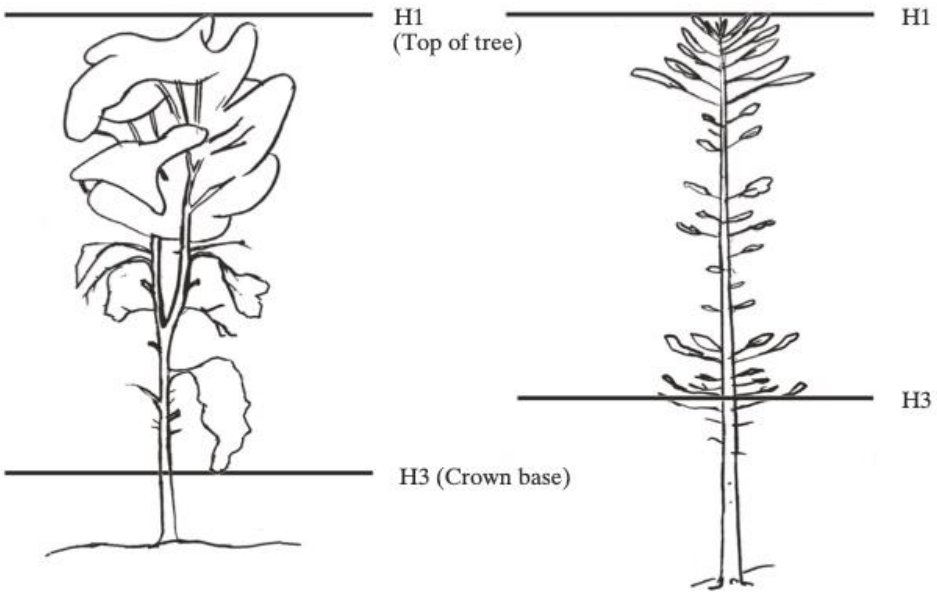


Figure 2.3: Height of crown

STA 211 Tree quality classes

In Romania we have 4 quality classes according to the percent of the industrial wood

Species	Classes	Percent of the industrial wood	Industrial wood usage percentage	Fire wood usage percentage
Evergreen	1	> 0.6	98	2
	2	0.4-0.6	83	17
	3	0.1-0.4	62	38
	4	<0.1	15	85
Deciduous	1	>0.5	83	17
	2	0.25-0.5	64	36
	3	0.1-0.25	41	59
	4	<0.1	15	85

STA 212 Forked tree

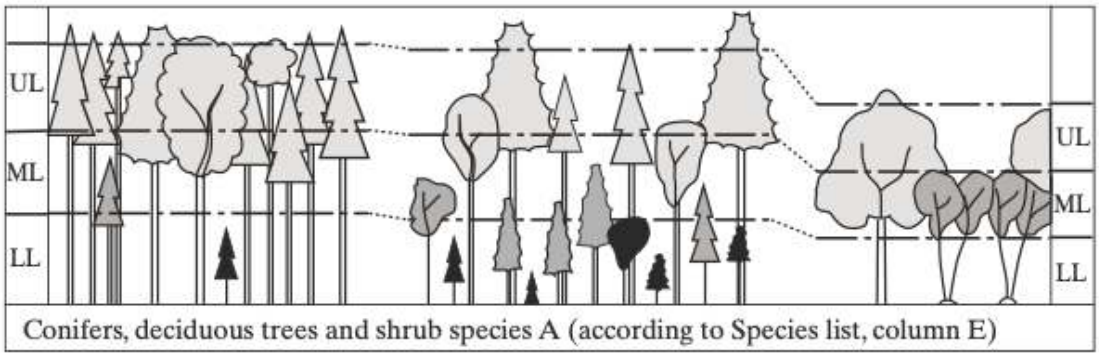
The characteristic 'forked tree' is included in the volume calculation. Tree forks are considered to be microhabitats as well. Forked trees are trees whose stem divides between 1.3 m and 9.0 m in height but below the crown base, whereby the thinner forked branch must be at least half as thick as the thicker one. This also includes trees of which one forked branch or both are dead. (A tree is recorded as a forked tree as long as it is recognizable as such).

code	Explanation
0	Without fork
1	With fork

STA 213 Layer

The layer defines the position of the treetop in relation to the top height (= average height of the 100 strongest trees per ha). The position of the crown top is decisive for the assignment of a tree to a certain layer. The characteristic 'layer' is taken into account in the volume calculation and

must therefore also be addressed for lying, broken and dead trees. The original stratum affiliation is evaluated. In the case of standing dead trunk parts and in the case of living trees with trunk fracture or crown fracture, the presumed stratum affiliation of the intact tree is recorded. In the case of living and dead lying trees, the former class affiliation of the standing tree is estimated. The following layers are possible (Figure 2.4):



Upper layer UL = > 2/3 of the top height
Medium layer ML = 1/3 – 2/3 of the top height
Lower layer LL = < 1/3 of the top height

Figure 2.4: Layer assignment

Code	Explanation
1	UL- Upper storey
2	ML- middle storey tree crown is between 1/3 and 2/3 from canopy height;
3	LL – under storey tree crown is below 1/3 from canopy height;
4	undefined (less than 3 sample trees within the 500 m^2 circle)

Information on Growth habit of sample trees

STA 214 Growth habit

Code	Explanation
1	Dendriform growth (including forked trees)
2	Shrub like growth (Often more than one stem axis; ramification near the ground, axis with growth restricted to ≤ 5 m) *On shrubs, no additional characteristics are being recorded, continue with the next tree*
3	Double-/Multiple stem (Stem divides below 1,3 m, growth habit is still dendriform. Both stems with DBH ≥ 6 cm. Other stems can be dead as long as on 50 cm height the cross- section is still 75% intact. On all stems of a Double-/multiple stems, DBH measurement height is individually defined from in accordance with Figure 2.1

STA 215 Tree vitality

Code	Explanation
0	normal
1	dying

STA 216 Stem form

Code	Explanation
-9	impossible to establish (e.g. broken stem)
0	straight tree

1	inclined tree (>15g from the vertical line)
2	highly curved tree (the tree crown is bellow insertion point)

Trees that are curved next to the collar, but otherwise grow straight (in the case of swollen trees) are considered straight trees (class 0). The same situation for S-shaped stems or slightly curved crown, which do not fit criteria 2 and 3.

STA 217 Tree origin/ tree provenance

It will be recorded the tree regeneration mode.

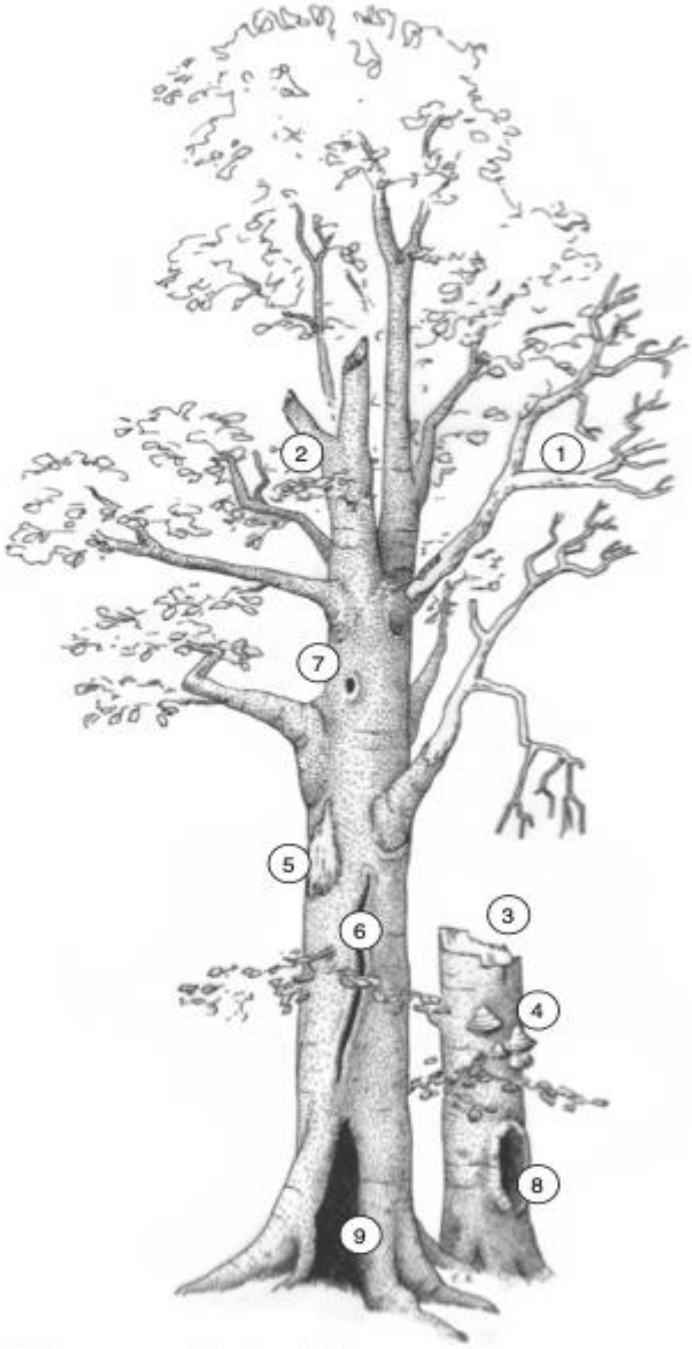
Code	Explanation
0	Seed
1	coppice

STA 218 Crown diameters

It will be measured two diameters (uphill- downhill (dc1) and contour line (dc2)).

Information regarding habitat trees

Habitat trees are living trees with special features, such as broken stems, cracks, holes or cavities, that provide microhabitats for specialized animals and plants.



Habitat trees with microhabitats

1 Crown with deadwood ≥ 10 % of crown volume
2 Broken crown (branches or bole) ≥ 10 % of crown volume
3 Broken stem
4 Polypores
5 Bark damage (bare wood core) ≥ 300 cm^2
6 Cracks in wood core ≥ 1 m length
7 Hole in wood core with a diameter ≥ 3 cm and a depth ≥ 5 cm
8 Cavity with mull wood at the stem base below 1.5 m in height
9 Hollow stem with a hollow diameter ≥ 50 % of tree diameter

STA 219 Crown breakage

The broken crown represents a part of the tree crown is broken to which are added the broken branches or the broken tree top. The breaking area must be visible and not bark covered. The part of the broken crown must be at least 10% of the total volume of the crown (in the case of forked trees, the forks are from the same crown).

Code	Explanation
-9	impossible to establish (e.g. broken stem)
0	without broken crown
1	<50% from crown volume is broken
2	>50% from crown volume is broken

STA 220 Stem breakage (living trees)

A stem breakage is considered to have occurred when the entire crown has been broken off and at the most there are still epicormic branches below the breakage. A stem breakage is only recorded on trees that are at least 0.5 m tall up to the point where the trunk cross-section is still 75% intact.

Code	Explanation
0	Intact stem
1	Broken stem

STA 220. 1 Fracture with many splinters / substitute crown (living trees with stem breakage).

In addition, one of the previous observations (14), additional features will be added to the trees with the broken stem:

Code	Explanation
0	No additional characteristic
1	Fracture with more than 10 splinters ≥ 50 cm
2	Substitute crown (upwards growing branch with diameter ≥ 6 cm, which towers above the fracture and forms a new crown)
3	Fracture with splinters and substitute crown.

STA 221 Deadwood in crown

Crown deadwood is recorded when crown-forming main branches are dead but still mostly intact. At least 10% of the crown volume must be affected.

Code	Explanation
-9	Not applicable (e.g. broken stem)
0	No or up to 10% dead wood in crow
1	10-50% dead wood in crown
2	>50% dead wood in crown

Tree related microhabitats sample plot inventory

STA 222 Cracks, splits

Cracks and fissures are cracks with a length of ≥ 1.0 m along the trunk axis, where the wooden body is visible and the crack enters the wood. Cracks and fissures are recorded along the entire log axis (as far as visible). With forked trees both trunk parts are looked at, with dissolved crowns without continuous trunk axis also the upward growing main branches. Closed and overflowed cracks are not taken up any more, because they are no longer of importance as habitat structure. The minimum criteria apply to a single crack, i.e. if several cracks are present, at least one must meet the above criteria (no addition of several cracks).

Code	Explanation
0	No cracks
1	One crack of 1-2m lenght
2	One crack of > 2 m length
3	Several cracks of ≥ 1 m length

Cracks which form the entrance to a cavity with decayed wood / duff / mull are not recorded as cracks.

STA 223 Bark lesion (living trees)

A bark lesion is a bark injury on the trunk that is visible on at least one surface the size of an A5 leaf (311 cm^2, about 2 palms) and a minimum width of 5 cm (an injury of 5 cm width must be at least 62 cm long) with the wooden body exposed. Bark lesions are recorded along the entire stem axis (as far as visible). The largest bark lesion is assessed (no addition of injuries). In the case of forked trees both fork parts are examined, in the case of dissolved crowns without a continuous stem axis also the main branches growing upwards. Possible causes of bark injuries are for example: Falling tree, falling rocks, bark stripping by animals, bark detachment after sunburn or beetle infestation.

Code	Explanation
0	No bark lesion
1	bark lesion A5-A4
2	bark lesion > A4-size (623 cm^2)

STA 224 Sap flow (living trees)

Sap flow occurs along the stem of broadleaved trees and silver fir. Possible causes include injuries caused by woodpeckers or fungi. Sap flow is recorded along the entire stem axis (as far as visible). In the case of forked trees, both parts of the fork are examined; in the case of

dissolved crowns without a stem trunk axis, the main branches growing upwards are also examined.

Code	Explanation
0	No sap flow
1	Sap flow present

STA 225 Cavity with decayed wood (all sample trees)[1]

Cave at the foot of the trunk (below 1.5 m height) with mould. Mould is a very loose or powdery wood mass, which is hardly connected anymore. The diameter of the opening must be at least the size of a fist, the presence of mulm must be checked (caution: the cavity can be inhabited by wasps or bees)!

Code	Explanation
0	No cavity with decayed wood
1	Cavity with decayed wood present

As soon as the cavity developed to a hollow stem, only the characteristic hollow stem is being recorded.

STA 226 Hole in stem (all sample trees)

The smallest diameter of the opening must be ≥ 3 cm, the hole must reach at least 5 cm into the wooden body. Origin unimportant: A hole can be caused by woodpeckers (food, brood cave) or as a result of a broken stick. Holes are recorded along the entire stem axis (as far as visible). With forked trees both trunk-parts are addressed, with dissolved crowns without continuous trunk-axis also the upward growing main-branches.

Code	Explanation
0	No hole
1	one hole in the stem
2	several holes in the stems

STA 227 Hollow stem (all sample trees).

Hollow trunk with opening up to 1.5 m height: At least 50% of the trunk diameter must be affected; the cavity extends at least 50 cm parallel to the course of the trunk.

[1] Be careful: hollow can be populated by potentially dangerous insects (wasps, bees)

Code	Explanation
0	No hollow stem
1	Hollow stem

STA 228 Polypores

The occurrence of polypore's is recorded along the entire stem axis (as far as visible). In the case of forked trees, both fork parts are addressed; in the case of dissolved crowns without a continuous stem axis, the main branches growing upwards are also addressed. Polypores that are smaller than 5 cm at their widest point are not recorded.

Code	Explanation
0	No polypores
1	Polypores present

All habitat structures (HS) occurring on a tree are indicated individually if they are:

- have different causes (example: If a tree bears an extensive bark injury, a woodpecker hole and polypore's, all three characteristics are recorded).
- A habitat structure that has arisen from a single event or developed by decomposition from another HS (e.g. hollow trunk that has developed from a cavity with decayed wood and this in turn has developed from a crack) is given only as one characteristic (no multiple recording). The following priorities apply (with decreasing significance from 1 to 5): 1. hollow trunk, 2. Cavity with decayed wood 3. Crack / Fissures 4. Hole in stem 5. Bark lesion.

STA229 Lobaria pulmonaria (all trees)

The *Lobaria pulmonaria* will be recorded for the entire stem (if it is present). For the forked trees all the forks will be analyzed.

Code	Explanation
0	Without *Loboria pulmonaria*
1	with *Loboria pulmonaria*

STA 230 Stem breakage with splinters

This information will be recorded only for the standing dead stems or stumps (from chapter 2 – tree status code 38 or 39). A snag with splinters is considered when the broken part has many splinters with length greater than 50 cm.

Code	Explanation
0	Snag without splinters (or few splinters with L <50 cm)
1	Snag with multiple splinters with L ≥ 50 cm

STA 231 Snags/stump height (standing dead trees, tree status 38 or 39)

The snag height will be measured using the Vertex (or equivalent equipment), until the longitudinal section is intact at least 75% (fig. 2). The volume of dead trees (code 35, 36, 37) according to yield/ tariffs tables (for living trees) or local formulas. For local volume formulas (tariffs), additional diameters along the stem can be measured using a Criterion 1000 RD equipment (half of snag height diameter, upper stem diameter).
For the standing intact dead trees (code 36) the total height will be measured to the tree top (similar to the living trees protocol).

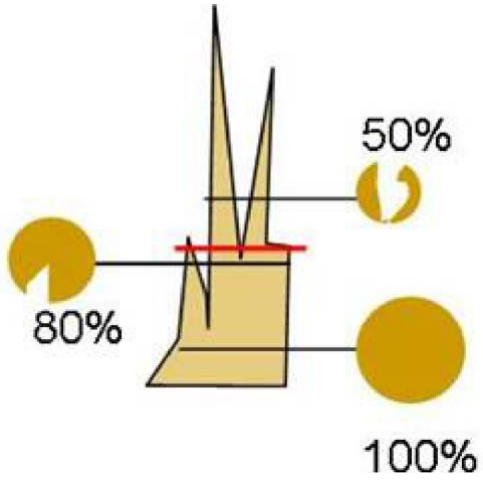


Fig. 2. The red line represents the height of the intact stem (measured upstream). To the left and to the right is represented the longitudinal section integrity (in percent and graphically)

STA 232 Wood decay classes

The wood decay level (classes) will be recorded for both standing dead trees (intact trees, snags and stumps) and fallen dead trees and course woody debris. A knife will be used for decay testing.

Code	Explanation
1	**Fresh deadwood** (the cambial cells still alive), sap is still present.
2	**Hard deadwood** (no sap, firm, a knife can hardly penetrate along the wood fibers) - (not decomposed)
3	**Mouldering wood** (less firm, knife penetrates the wood (>1cm) along the wood fiber easily (initial decomposition).
4	**Mouldering wood** (soft, knife penetrates the wood (>1cm) perpendicular to the wood fibers (or each direction) easily (strong decomposition).
5	**Mull wood** (the entire wood is very soft).

Sheet 3 Lying dead wood information

Lying deadwood not only includes complete trees, but also broken stems, tree fragments and broken-off parts from standing trees. The volume of lying dead- wood was defined as the total volume of lying dead-wood pieces with a diameter of ≥ 7 cm (over bark, thicker end), and 1.0m minimal length Thus, a single piece of deadwood may have a section (coarser than 7cm) accounted for in the lying dead- wood volume and a section (smaller than 7 cm) not accounted for in the lying deadwood volume. Only above-ground material is included in lying deadwood.
The variables measured in the field were: the diameter (crosswise measurements) both ends (thicker and thinner) and half of the lying stem, the decay class (5 categories), the tree species group (code 800 - broadleaves, code 390 – conifers and 999 unidentified), the coordinates (of the both ends) using the FieldMap system.

Lying DW volume estimation formula [m^3/ha] – according to Böhl and Brändi (2007) - NFI

$$Y(x_l) = \frac{1}{h_l} \sum_{k=1}^{h_l} \frac{\pi^2}{8L_k} \sum_{i=1}^{N(k)} \left(\frac{D1_i + D2_i}{2}\right)^2 \frac{1}{cos\ cos\ \alpha_i}$$

$Y(x_l)$- estimated lying dead wood [m^3/ha] on the sample plot (x_l)

h_l- Number of transects on sample plot (x_l)

L_k – Horizontal length of the k^{th} transect

$D1_i, D2_i$ – Diameter of deadwood piece *i* [cm], measured crosswise
α_i – inclination of the dead wood [degrees]

$N(k)$ – Number of deadwood pieces on the k^{th} transect

Transect assessment (Lying deadwood)

Deadwood is an important component of forest ecosystems. The different stages of decay of deadwood serve as food and habitat for a variety of organisms. Deadwood is therefore of crucial importance for the conservation and promotion of forest biodiversity. The measurement of deadwood transects serves to estimate the volume and the decay stage of lying deadwood. The total deadwood volume is calculated as the sum of the standing and lying deadwood. The lying deadwood is recorded on three line transects of 15 m length each (horizontal distance). The transects start at a distance of 1 m from the plot centre (SSPC) and run in the direction of 30^o, 150^o and 270^o.

The assessment of the three deadwood transects are done one after the other. After the first transect has been assessed, the second transect is measured, and finally the third transect.

DW301 Time recording

At the beginning of the dead wood transect photographs the time is recorded.

1.1 Transect information

The following information is provided for each transect.

DW 311 Transect direction [degree]

1. 30°
2. 150°
3. 270°

DW 312 Transect inventory

Due to terrain-related obstacles and accessibility boundaries, the assessment can sometimes only be carried out in part. This requires the specification:
1. entire assessment
2. partial assessment
3. no assessment

DW 313 Transect inclination [%]

In inclined terrain, the transect length must be adapted to the slope of the terrain. This requires the measurement of the transect inclination. The transect inclination is measured at a distance of 16 m from the SPC in transect direction with the inclinometer and indicated in %. For this purpose, one of the team members is instructed on the correct measuring position from the SPC by means of bearing through the compass. With only partial recording, the transect inclination is measured from the end of the measurable distance at the obstacle.

DW 314 Transect length [m]

The transect length is the slope distance from the end of the (measurable) transect to the SPC (i.e. including the meter not to be recorded at the SPC). The normal length in flat terrain is 16 m (= horizontal length). The inclination-corrected transect length (slope distance) is specified by the recording program. In the case of partial assessment of the transect, the measurable transect length (slope distance) is measured to the nearest cm from the obstacle along the transect to the SPC (including the meter not to be recorded at the SPC) and specified.

DW 315 Transect length partial assessment (DW312 = 2) [m]

If the deadwood transect cannot be entirely assessed (DW 312 = 2), the slope distance from the end of the accessible part of the transect to the SPC is recorded.

1.2 Deadwood pieces

Lying deadwood is included soon as the mean diameter of the piece at the point where it cuts the transect is at least 7 cm (measured perpendicular to the central axis of the deadwood piece and crosswise to it). Deadwood pieces are logs, trunks and branches lying on the ground, regardless of whether they belong to a dead lying sample tree that has already been assessed or not.

Do not count as pieces of dead wood:

- Pieces of mean diameter ≤ 7 cm.
- Lying trees that still show signs of life *Dead branches on standing trees, roots or tree stumps that are still rooted in the ground and whose stem axis deviates less than 45 degrees from the vertical. Bark pieces, branches or trunks that are completely or partially covered by soil at the interface with the transect. Wood that is already weathered to soil substrate*

Procedure:

- All pieces of deadwood cut from the transect line and meeting the above criteria are recorded.
- A piece is recorded multiple times if it is cut multiple times by one or more transects.
- If the transect leads through a pile of branches or a crown of a dead tree lying on the ground, all branches with a mean diameter of ≥ 7 cm are recorded at the intersection with the transect, including those branches which themselves have no contact with the ground.
- If the diameters in a branch pile cannot be measured, they are estimated.

Only the measurement of the mean diameter of the piece of dead wood at the transect intersection and the measurement of the angle of the piece (deviation from the horizontal) at the transect intersection are required for the calculation of the horizontal dead wood volume. The measurement of the length of the dead wood piece is not necessary.

2.1 The following characteristics are recorded for each piece cut by a transect:

DW 321 Piece number

Each piece of deadwood recorded is assigned a consecutive number. If a piece of deadwood is cut several times by a transect, it is given a new number each time. The numbering starts at 1 for each transect and is automatically generated by the recording program.

DW 322 Diameter 1 [cm]

The diameter of the deadwood piece is measured with the caliper at the intersection with the transect perpendicular to the central axis of the deadwood piece (Figure 1a, Figure 1b).

DW 323 Diameter 2 [cm]

Since the cross-section of deadwood pieces becomes increasingly uneven in the course of decomposition, a second diameter measurement is necessary. The second diameter is measured analogously to the first diameter but crosswise to it.

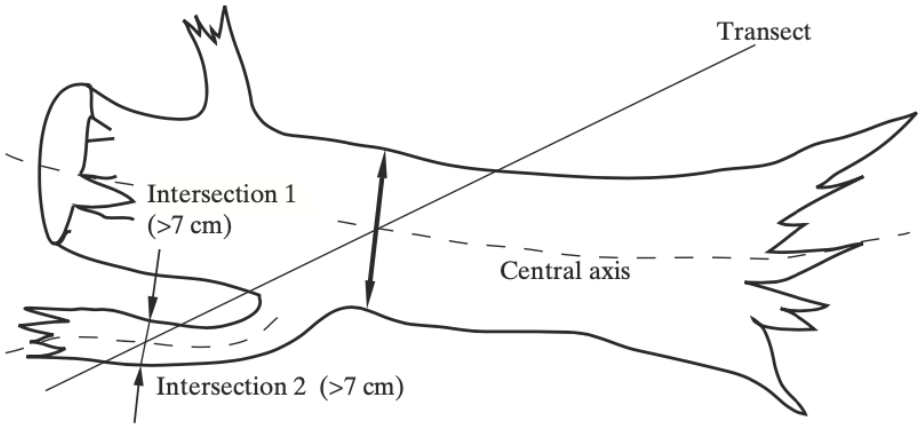


Figure 1 Diameter measurement during transect assessment

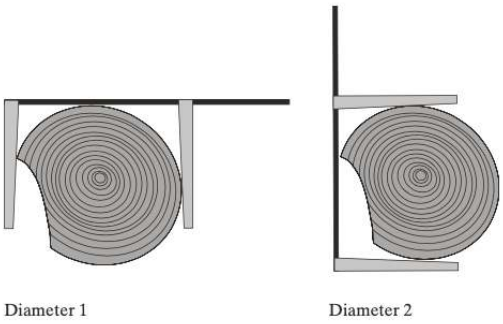


Figure 1b Diameter measurement using the caliper

DW 324 Angle piece of deadwood [degree]

The probability that a piece of dead wood will be cut by the transect line is related, among other things, to the angle of inclination that a lying piece of dead wood forms with the horizontal (Figure 2). This must therefore be taken into account in the formula for calculating the deadwood volume.

For the measurement, the gradient meter is placed on the deadwood piece in the longitudinal direction at the transect intersection and the angle with the horizontal is read accurately to 1^{o}. Attention: Especially with large inclination angles (>45^{o}) it is very important to measure exactly! For this propose, the Vertex can be used.

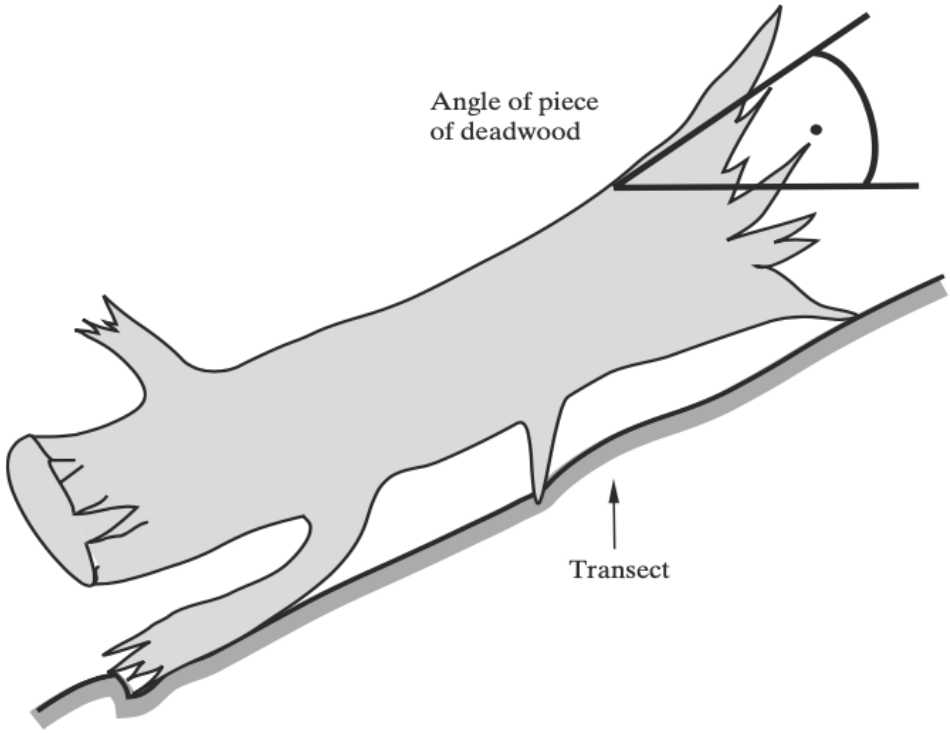


Figure 2: angle of inclination of the piece of deadwood

DW 325 Wood type

A distinction is only made between broadleaved and conifers. If the species can no longer be determined due to the degree of degradation, enter code 999.

390. Coniferous
800. Broadleaved
999. Cannot be determined

DW 326 Decay stage

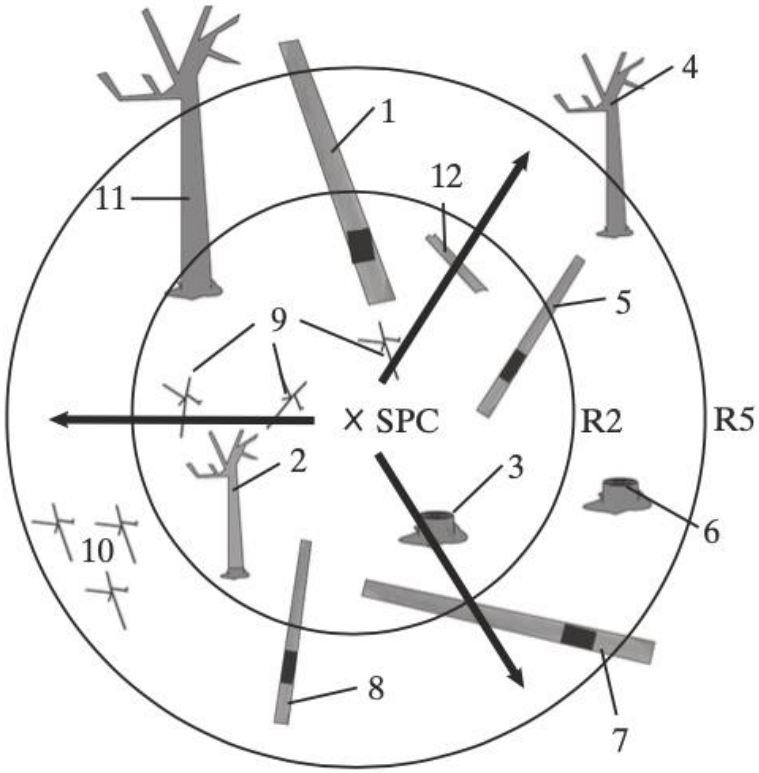
The decay of deadwood is determined by the knife test at the transect point of intersection on the upper side of the piece of deadwood, as with standing deadwood.

1. Freshwood, green (cambium might still be living)
2. Firm deadwood (Juyless, firm; hard, without sap; the blade can penetrate the material only slightly parallel to the fibres)
3. Rotten wood (less firm than 2, not very hard; the blade can penetrate the material easily parallel to the fibres, but it can penetrate only slightly across the direction of the fibres)
4. Mouldering wood (soft; the blade penetrates the material easily in all directions).
5. Mull wood (very loose or powdery; hardly any structure).

DW 327 Time recording transect assessment

The time is recorded at the end of the transect recording.

Dead wood inventory – working example



No.	Deadwood piece	RESFOR sample plot	Single tree assessment	Transect assessment
1	Lying dead, dbh = 45 cm	x	x	-
2	Snag, dbh = 27 cm	x	x	-
3	Stump	-	-	x
4	Snag, dbh =32 cm	-	-	-
5	Lying dead, dbh =26 cm	x	x	-
6	Stump of an project sample tree	x	x	-
7	Lying dead, dbh =42 cm	x	x	x
8	Lying dead, dbh =28 cm	-	-	-
9	Branches D ≥ 7 cm	-	-	x
10	Branches D ≥ 7 cm	-	-	-
11	Snag, dbh = 48 cm	x	x	-
12	Stem-piece, D≥7 cm	-	-	x

All the above information will be recorded in the FieldMap database.

Sheet 4 Biodiversity assessment

The biodiversity (flora, seedlings and regeneration (bellow the diameter threshold)) will be evaluated in four rectangular 1x1m subplots (figure 1 – sampling design). All plants and seedlings will be counted and recorded.

Tree coring

A number of 3 (5) cores from the sample plots will be cored using a sharped Pressler borer (5.5mm), one core per tree. The coring height will be set at 1.30m, on contour line. The cores must be extracted as much as possible intact (max in 3 parts will be accepted). The cores will be stored in plastic straws or in polycarbonate plates (8mm wide) (100x500 mm – cc 10 cores can be stored). The plastic straws/polycarbonate plates must be labeled using the plot name (number) and tree number.

Survey equipment

Survey instruments and material

1 FieldMap system (compass (TruPulse 360R or equivalent), field tablet, monopod or tripod).
1 foliage filter
2 reflectors
2 Ranging poles (2 m)
1 Hypsometer Vertex IV (or Vertex V) (to measure distances and tree heights)
1 Transponder for Vertex
1 Criterion RD 1000
1 GPS (Trimble Juno 3D or equivalent with ArcPad software)
1 Calliper Haglöff MANTAX 80 or 100 cm.
1 Diameter tape
1 Measuring tape 50 m (fibreglass)
1 Digital camera
Pressler bores (40 cm, 50 and 70 cm long)
Sharpening kit
2 Borer starters
Polycarbonate containers

The FieldMap compass must be always calibrated in the field!

Equipment and tools

2 Backpacks
2 Cruiser vests
1 Pocket knife (Victorinox Forester)
1 Club hammer
1 First aid kit
2 Oak poles (4 x 4 x 40 cm; one with and one without marking) per sample plot

Documents

1 Overview map on a scale of 1: 20 000 (based on GIS data (forest management plans), with orthophotos as background data) covering the whole study area
2 Field manuals (Romanian and Ukrainian)
Sets of forms on normal and waterproof paper notebooks
2 Cards with codes for sample trees (RO, UA)
2 User's Manual with brief instructions for FieldMap, Vertex and Transponder, Criterion RD 1000, GPS Trimble Juno 3B (all in English)