



Partnership for the development of training standards for tree assessors in Central and Eastern Europe  
PROJECT NUMBER – 2019-1-PL01-KA202-065670



**TREE  
ASSESSOR**

# Basics of tree inventory

Handbook for tree assessors and arborists

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## Handbook for tree assessors and arborists

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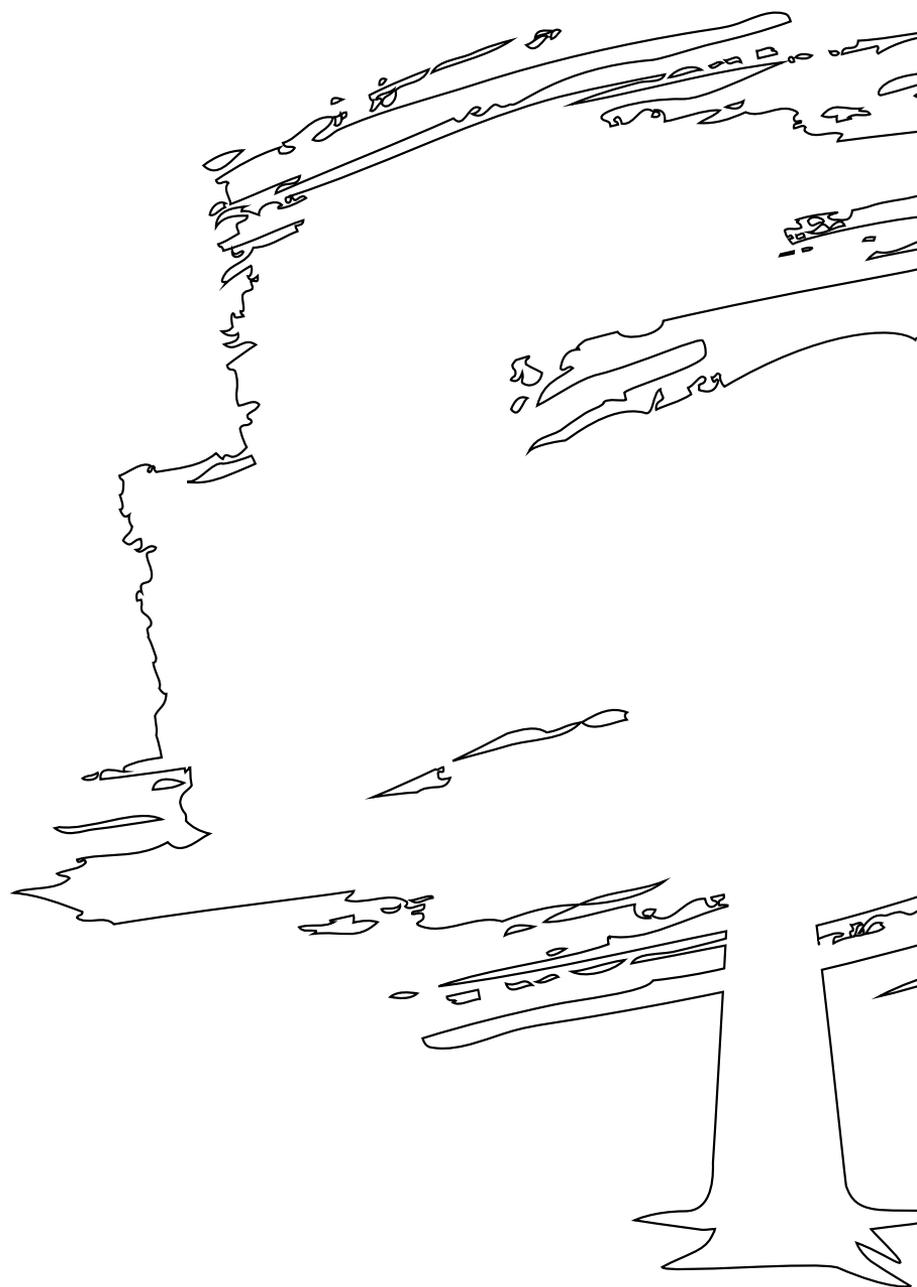
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# TREE ASSESSOR

## Basics of tree inventory

Handbook for tree assessors and arborists

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# *I.*

## *Inventory in tree evaluation*

### **FROM THIS CHAPTER YOU WILL LEARN:**

- What is a tree inventory
- Why we do a tree inventory
- How to collect basic tree data (tree identification information)

## **1. INTRODUCTION**

An inventory is a recorded stocktaking made in a way that allows verification. It is carried out both as a graphical representation on a map with a descriptive list (e.g. tabular) of the inventoried trees and the basic data on them collected during the inventory in the field. The inventory may serve various purposes (e.g. for the preparation of a construction project, as part of a park/garden regeneration project or for a tree assessment) and therefore, depending

on the needs, may vary in the detail of the data collected.

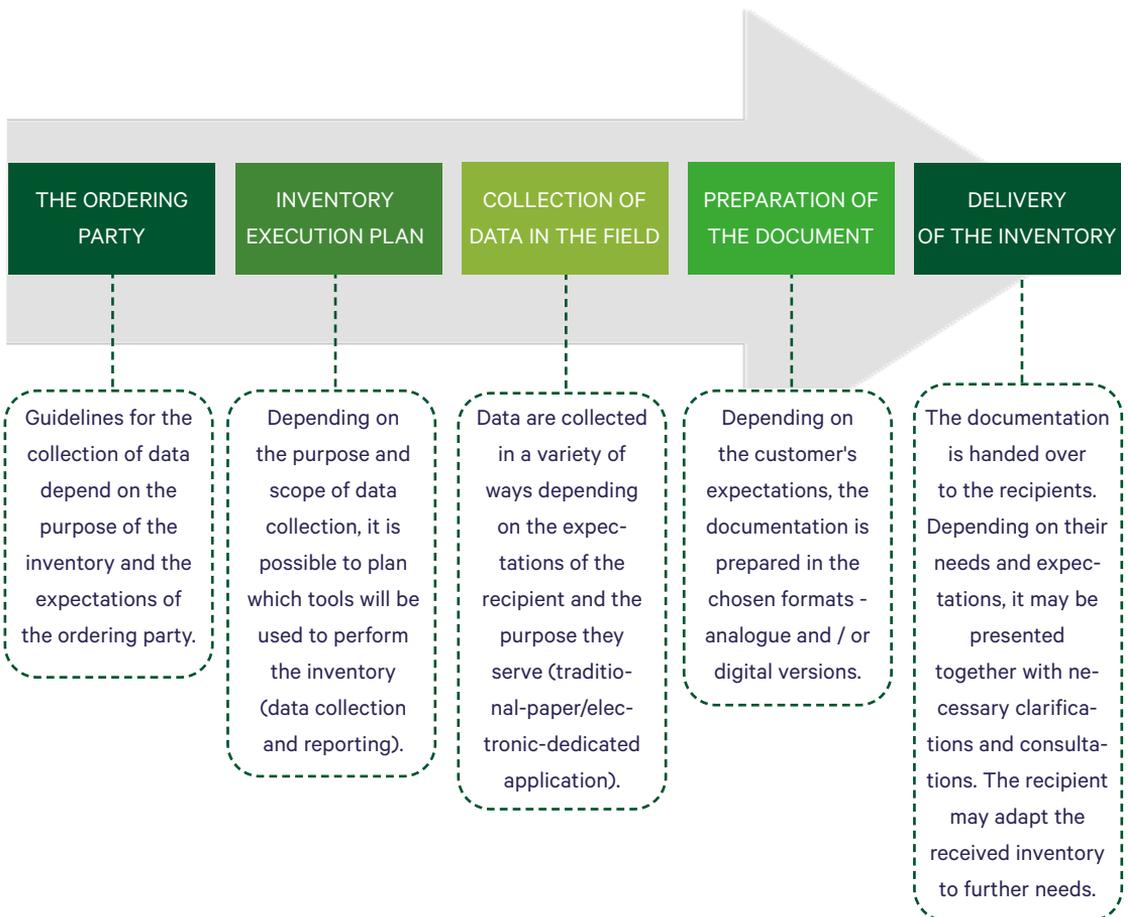
The data collected during the inventory can be used for further tree inspection, including advanced tree diagnostics, so a proper performance of which is one of the core competencies of tree assessors. It is not possible to perform a tree assessment without collecting basic tree data, so the inventory is the first step in conducting field work. This chapter brings together the

most important information to help learners perform tree inventories correctly.

It should be remembered that the inventory (and the data collected during it) can be an independent document, as well as an element

of another document or a part of a set of different studies forming a more complex report (depending on the needs). The basic stages of the inventory are shown in Fig.1.

Figure 1: The process of preparing an inventory.  
(Source: own elaboration).



## 2. THE ORDERING PARTIES, THEIR EXPECTATIONS AND GUIDELINES FOR DATA COLLECTION

The performance of a tree inventory starts with defining the needs of the ordering party. It is usually the user of the inventory and the purpose of the inventory that determine the scope of data to be collected. Typically, detailed guidelines are written in the contract or in the specification, in standard forms / applications for inventories, or communicated orally. It is particularly important to indicate which base map, what method and what accuracy should be used.

It should be remembered that, depending on the purpose of the inventory, it often does not constitute the final study, but starts a process in which individual data are collected one by one for a specific purpose. It can also be a verification of a previously made inventory, in which case the scope of data collection follows from the verified documentation.

### TIP 1

When undertaking a tree inventory, find out what is the purpose of the inventory, the concerned area, the scope of data collection and the mapping base.

#### Examples of questions that can help to define the scope of the inventory:

- is there an established **format** for data collection during the inventory exercise, if so, which one?
- is a **base map** established for marking the inventoried trees, if yes - what kind? (or is a map from the previous inventory available - when verifying the inventory made earlier).
- is there an established **tool for tree inventory (data collection) and/or its presentation** (e.g. a ready-to-use application), if yes, which one? Is it publicly available? Is it known to you?

### 3. AN INVENTORY IMPLEMENTATION PLAN AND TOOLS (FOR DATA COLLECTION AND REPORTING)

Before going into the field, it is a good practice to prepare and check the appropriate tools for collecting data during the tree inventory. It is also a good idea to spend some time checking the area to be covered by the inventory, to determine the location of trees and the boundaries within which the work will be done. Depending on the data collection tool used, it is advisable to prepare in advance a base map and a data collection format (e.g. a table with a set of columns for entering data from the field), print out the prepared data collection formats and maps, or prepare the range of data to be collected in the application and upload the base map to it. Using the application reduces the time you have to spend on transcribing data from the field data sheets and marking trees on the map, but it can also increase the time needed to inventory a single tree in the field. In the end, the work done with the application takes less time, but you need to anticipate how much

time you can spend on fieldwork and adapt to the method used to collect data in the field. If the order requires the geodetic location of the inventoried trees on the map, it is necessary to provide for the time of preliminary preparation of the map by the surveyor.

In cases where the amount of data to be collected is not large, it is possible not to use a form and to conduct the inventory process in a simplified manner, by recording the data with a voice recorder.

Use unique codes to mark trees in the field. If arbotags (tree identifiers) are not available, use your own tree tag numbers or other unique identifiers. Make sure that these markings are the same as the tree descriptions on maps and in tables/forms.

For the fieldwork a range of tools can be used (cf. Fig. 2).





Figure 2: Tools for the fieldwork during tree inventory.

(Source: own elaboration).



Think about spare tools in case of loss or damage, rechargeable batteries, spare batteries or

power bank, charger, spare memory cards. An umbrella can be useful in case of sudden rain.

## TIP 2

When planning the workload, take into account that the use of the application increases the time you have to spend in the field, but reduces the final time for completing the inventory. The need for a geodetic mapping trees increases the time and cost of producing the inventory. A voice recorder is the fastest tool for recording data in the field, but it significantly increases the time spent later in the office.

### Examples of questions that can help in inventory planning:

- Is it necessary to **geodetically** map the trees? If so, do you already have a map with geodetically localised trees?
- Do you know **where** you are going to make the inventory? if yes, do you know the boundaries that define the work area?
- In what **form** are you making the inventory? Do you have printed forms and maps, or do you have a tablet and maps uploaded to the tablet and an application prepared to collect data in the field, or will you be collecting data using a voice recorder?
- Do you have the necessary **measuring instruments** to collect data in the field?
- Have you prepared **arbotags** with the correct numbers for marking the inventoried trees and nails and hammer or pendants?

## 4. COLLECTION OF DATA IN THE FIELD

Conducting a tree inventory usually requires to collect data in the field. Exception are simplified area surveys which can be done remotely using a drone or aerial or satellite images in combination with appropriate computer software. A tree needs to be reached and identified by taking appropriate measurements, identifying the species (exceptionally, only the genus), marking it on a map and in the field with an arbotag. The inventory may serve verification, i.e. the trees have already been inventoried before, but it is possible that the material received for verification will contain significant differences in both measurable parameters and in the determination of the tree species and locations. It is important to remember that the most accurate base is the master map. When using applications, orthophotos are often used as the mapping base.

Reaching a tree is the first step of the inventory. We locate the tree on the map base as a point (additionally, if requested, we can record the geographical coordinates of the located tree), give it a number (unique for each tree. It is possible for the number to be unique for the area as well). by entering it on the map next to the located tree.

### TIP 3

When starting your fieldwork, make sure you have all the necessary measuring instruments and the documents & tools you will use in the field to complete your inventory. Determine whether you are in the right location. If more than one tree is to be surveyed, then prepare a work plan - a site walk - so that no tree is missed. Determine what data you are going to collect.

When verifying an existing inventory, remember that even numbering on maps and arbotags installed on a tree can be subject to errors. If you have the opportunity, compare the location of the paper map with online maps, e.g. orthophotos. If in doubt, contact the ordering party, land manager, or other person helpful in determining the location of the commissioned inventory.

Inventories made previously using special applications, as well as arbotags mounted on the trunks, make it much easier to locate trees and speed up the work.

## WHAT DATA DO WE COLLECT IN THE FIELD AND HOW DO WE COLLECT IT?

The data collected can be divided into 3 groups:

### BASIC DATA

- tree designation on the map - as a unique identifier for the tree, either based on the previous survey or a newly generated number
- identification of tree species
- girth of the tree trunk

### SUPPLEMENTARY DATA

- tree height
- diameter of the crown

### ADDITIONAL DATA

- marking with a tag (arbotag)
- clearance height
- height of crown base
- crown height

The basic data to identify a tree are the tree designation on the map, the tree species and the trunk girth. Additionally, other tree characteristics such as tree height and crown diameter can be collected. When required, the height of the crown base, the clearance height and the crown height are also collected and arbotag is fixed on the trunk. Although marking a tree with an arbotag is not the primary task, it is recommended that it is used as it is the most accurate and quickest way of finding the tree in the field.





### TREE SPECIES

It is one of the most important characteristics for identifying a tree. Therefore, as a general rule, trees are identified at the species level and only exceptionally (in justified cases and in agreement with the client), a simplified identification to genus level or extended to include variety can be used. E.g. the restriction to genus may be applied in agreement with the contracting organisation when the assessment is made outside the growing season for deciduous trees. All name entries should conform to the International Code of Botanical Nomenclature<sup>1</sup>. Trees that cannot be identified at genus level or that are not recognised by the ICBN should be described as 'unknown'. As a rule, the name used in the country in question is given. If the order indicates this, the Latin name should also be included.

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1 International Code of Nomenclature for algae, fungi, and plants, 2018. <https://www.iapt-taxon.org/nomen/main.php>

### TRUNK CIRCUMFERENCE

Next to the tree species, the stem girth is a basic parameter to help identify a tree in the field. It is important to remember that when verifying measurements or finding a tree some time after an inventory has been taken, the parameters may now be different (usually higher, because trees grow in thickness and height). The size of the tree trunk is usually recorded as the girth measured at 130 cm above ground level.

The height at which you measure should in principle be determined parallel to the axis of the tree. Exceptions to the rule are described further on. We use CF-certified flexible tree measuring tapes (both steel and plastic) to measure trees.



#### TIP 4

During the leafless period, the determination of a deciduous tree species can be based largely on the characteristic features of shoots, buds and leaf scars.

When determining the species of deciduous tree in the leafless season, atlases, guides and keys for determining trees in the leafless state may be helpful, e.g. *Recognition of Ornamental Trees and Shrubs in the Leafless State* by T. Szymanowski, PWRiL Warsaw 1974; *Atlas pędów zimowych* by J. Adamczyk, Multico 2022.

Measurements made for administrative proceedings should always be done in accordance with the applicable law<sup>2</sup> (absolutely at the height specified in the special regulations). Exceptionally (at the request of the ordering party) the measurement of the trunk diameter may be used as the only or additional parameter (performed at the height of 130 cm it is called the breast height - DBH).

The diameter of the trunk is usually measured using a diameter gauge (also known as a clump gauge). In this case, take two measurements

(taken 90 degrees apart) and calculate the average, which is then used as the result. If this measurement is taken using a tape measure with a scale indicating the stem diameter measurement, we take one measurement, as for the stem circumference.

Trunk measurements shall be expressed in full centimetres. In case of incomplete values the measurement shall be rounded off to the nearest centimetre.

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2 eg. Polish legislation, e.g. Art.83b (1) (5) of the Act of 16 April 2004 on Nature Conservation (Journal of Laws of 2021, item 1098).

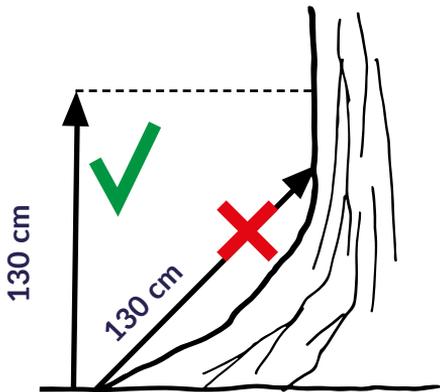


Figure 3: The stem thickness measurement must be taken at a given height measured parallel to the stem axis.

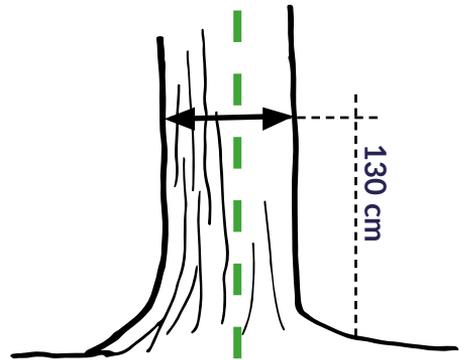


Figure 4: As a rule, measurements should be taken at a height of 130 cm, parallel to the axis of the tree trunk.

When trees are irregularly shaped or the terrain is sloping, the following rules apply for measuring stem thickness:

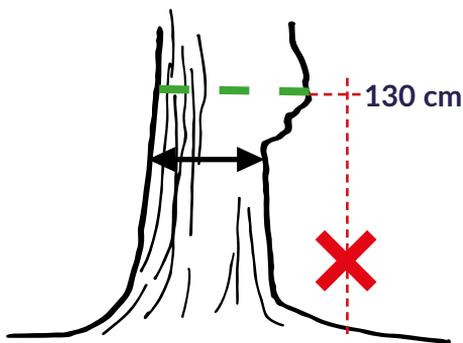


Figure 5: Tree with irregular trunk thickness - measure at the narrowest point, as close as possible to 1.3 m height.

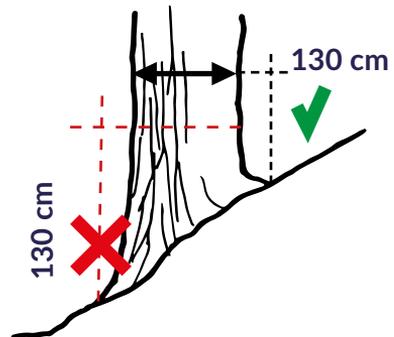


Figure 6: Trees growing on a slope - measurements should be taken from the highest point of contact with the ground.



Figures 7 and 8: Incorrect measurement of trunk circumference on slope. (PW)



Figures 9 and 10: Correct measurement of trunk circumference on the slope. (PW)

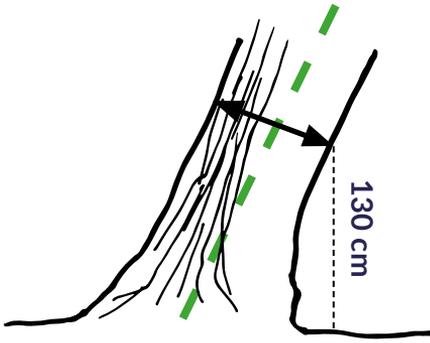


Figure 11: Sloping trees - measurements should be taken from the sloping side, parallel to the axis of the trunk.

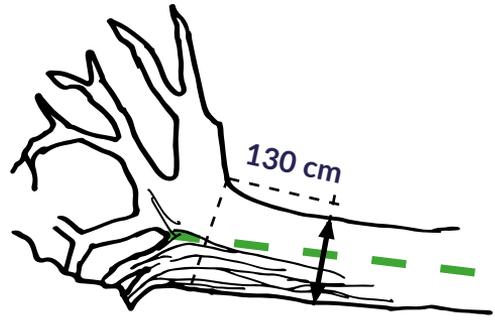


Figure 12: Lying trees - measurements should be taken at a distance of 1.3 m from the base of the stem, measured parallel to its axis.

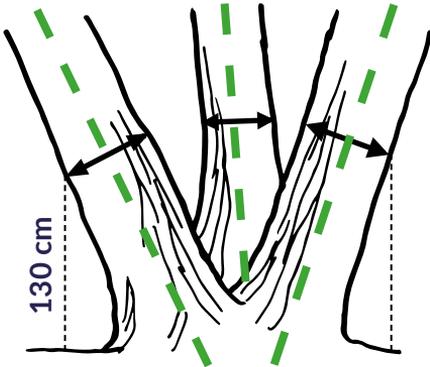


Figure 13: In the case of multi-stem trees (where the bifurcation is below 1.3 m in height), the dimensions of each stem shall be given, indicating that it is a multi-stem tree. When giving dimensions, the circumference of the thickest stem shall be indicated first.

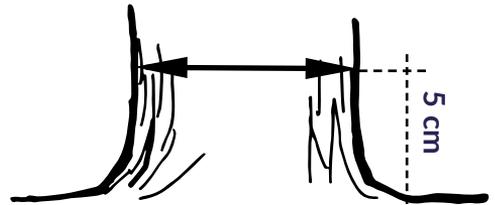


Figure 14: Additional measurement taken at 5 cm height.

In case the inventory serves the purpose of administrative procedure or it is known that on the basis of the inventory tree felling is planned (or it results directly from the order), additional parameters resulting from local regulations may be given, e.g. in Poland in 2022 these would be the following parameters:

- In the case of multi-trunk surveys, the parameter shall be the sum of the circumference of the thickest stem and half the circumferences of the others.



- In the event that the measured circumference of the tree trunk (at 130 cm) is less than the parameters indicated below, an additional stem girth measurement shall be taken, measured at 5 cm height<sup>3</sup>:

**80 cm** - in the case of poplars, willows, boxelder and silver maple,

**65 cm** - in the case of horse chestnut, black locust and London plane,

**50 cm** - for other tree species;

**ATTENTION - the rules indicated above result from specific provisions<sup>4</sup> and may change, therefore each time this should be verified in the applicable legal acts.**

### TREE HEIGHT

The height of a tree can be determined for various purposes, e.g. for statics calculations in advanced tree assessment (diagnostics), to determine risks in the tree's surroundings, to estimate the effects of shade on the environment in the design process. It is defined as the distance from the base of the trunk to the top of the crown.

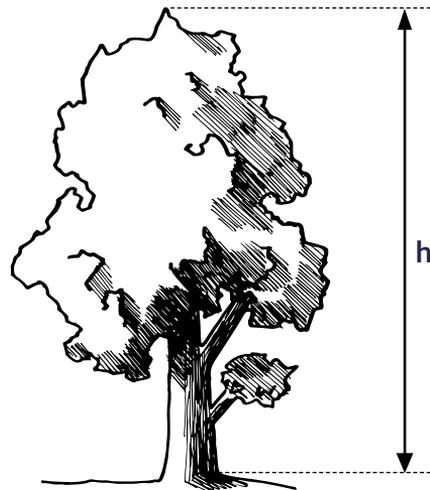


Figure 15: Tree height.

3. The legitimacy of carrying out this measurement results from Article 83f section 1 point 3 of the Act of 16 April 2004 on Nature Conservation (PL).

4. Nature Conservation Act (PL).

The height is given in meters rounded off to the nearest 0.1 m. The accuracy of a measurement depends on the survey requirements and the measurement method applied (including the accuracy of the measuring instrument). Altitude is measured with instruments (tools) used for this purpose. These can be: altimeters used in forestry, mechanical (e.g. Suunto), electronic, laser or ultrasound instruments. Each of these has its advantages and disadvantages. The exact determination of the tree height can be subject to errors due to the instrument used and the resulting limitations (e.g. misestimation of the correct (horizontal) distance between the measurer and the tree). In the case of a tree growing on a slope, a distance from the tree taken at an angle (resulting from the slope of the terrain) should be taken horizontally. Another factor that has a significant influence on the tree height measurement is correct identification of the tree top, which often cannot be determined unambiguously.

It is worth remembering that the main limitation of the Suunto altimeter (mechanical) is the fixed distance from the tree at which the measurement can be taken, i.e. 15 or 20m, as the reading on the



*Figure 16: Incorrect tree height measurement, taken at a distance less than the tree height. (MK)*



*Figure 17: Correct tree height measurement taken at a distance greater than the tree height. (MK)*

altimeter scale is assigned to these distances. It is also possible to take a measurement from a distance which is a multiple of 15 or 20m, in

which case the reading on the scale should be multiplied by the applied factor.

## TIP 5

One of the most important factors for correctly measuring the height of a tree is the distance from which you measure, irrespective of the measuring tool used. If there are no other instructions, this distance should be at least equal to the height of the tree. The greater the distance, the more accurate the measurement. The shorter the distance, the more erroneous the measurement.

The distance from the tree is always measured horizontally; it is a mistake to measure the distance parallel to the ground if it is uneven.

Depending on whether your eye is located between the base of the tree and its top (Fig. 19) or below the base of the tree (Fig. 20), the readings on the measuring device need to be either added (Fig. 19.  $AB+AC$ ) or subtracted (Fig. 20.  $AB-AC$ ).

It is easy to determine the distance to the tree (using a measuring tape or rangefinder) in relatively flat terrain (Fig. 19. A-D), but it becomes difficult to determine this distance on slopes when the base of the trunk is above our eye level (Fig. 20. A-D), because such measurement would be taken at an angle. The same is true when our eye is above the top of the tree being measured (Fig. 21. A-B), as we are unable to determine the correct horizontal distance from the tree. A tree height measurement taken in this way will have a significant error. The distance to the tree can be measured correctly if the measuring eye is between the base of the tree and its top.

An equally important factor influencing the accuracy of height measurements is the deviation of the tree from the vertical (Fig. 18). If the measurement is taken in the direction of the inclination of the tree from point D, the resulting value B-F is greater than the actual height of the tree, but if the measurement is taken in the direction opposite to the tilt of the tree from

point A, the resulting value C-G will be smaller than the actual height of the tree. In such cases, height measurements should be taken from a direction perpendicular to the inclination plane of the tree or the average of the height measurements taken from the two opposite directions (towards inclination D and opposite to inclination A) should be used.

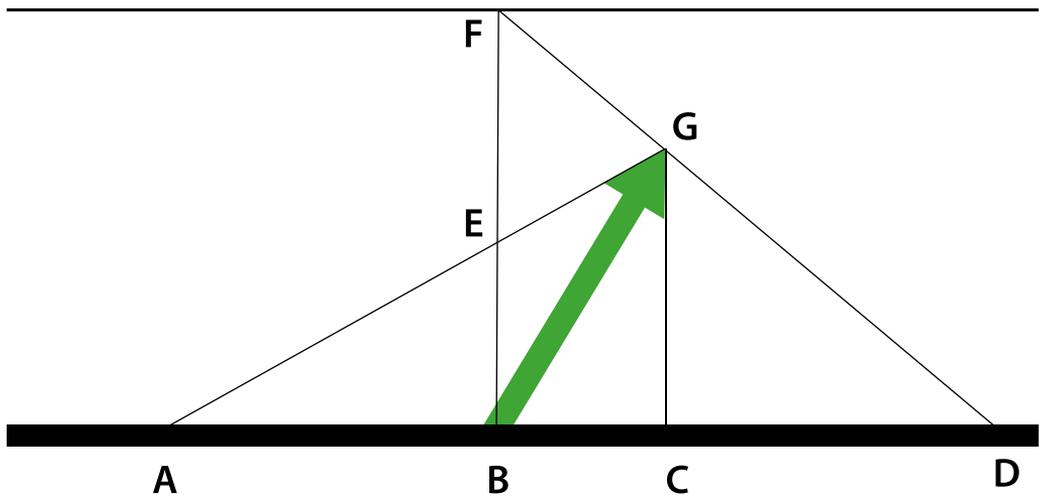
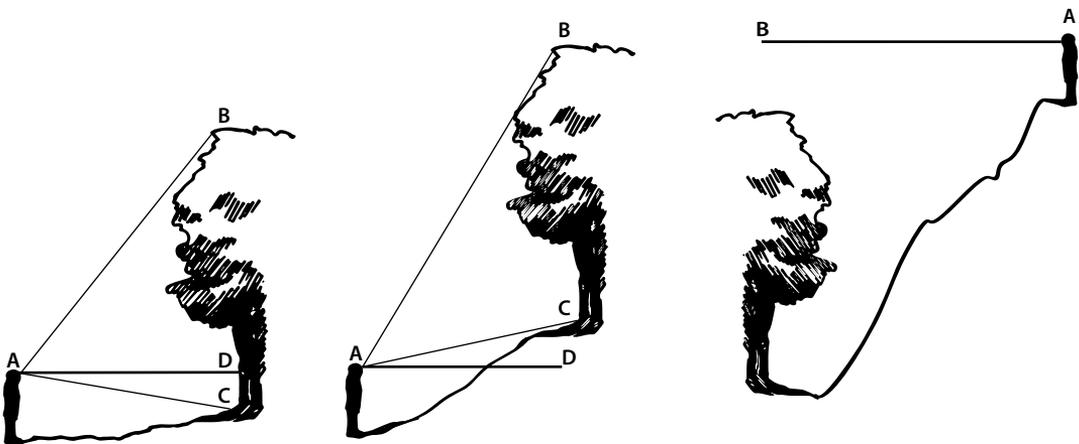


Figure 18: Determining the height of a leaning tree.



Figures 19, 20, 21: Distance to tree measured correctly (left), distance to tree measured with potential error (centre and right).

### CROWN DIAMETER

It can be determined for various reasons, e.g. to estimate the impact of a planned development on a tree, the impact of the canopy on a planned development (e.g. collision with clearance), the impact of the canopy extent on the environment in connection with designing buildings and landscape.

The diameter of the crown is determined as the average of the measurements of the two perpendicular widths of the dripline. This measurement is made according to geographical directions (Fig. 22a): one measurement East/West, the other North/South. The crown diameter can also be given as the sum of the two perpendicular longest radii measured from the trunk to the dripline (Fig. 22a). The measurement for a symmetrical crown follows the main geographical directions (East / North; East / South; West /

North; West / South). In the case of a strongly asymmetrical crown (irrespective of whether radius or crown diameter is measured), one measurement is taken in the longest axis and one in the direction perpendicular to the first measurement (Fig. 22b) - both values must be given. The measurement is given in metres, rounded to the nearest 0.1 m.

When the measurements are to be used for the advanced assessment of a tree (diagnostics) or to determine the influence zone of a tree crown (e.g. in the course of a construction project), it is possible to measure the radii of the longest and shortest axes and to indicate their geographical directions (in degrees). Measurements are taken with measuring tapes or range finders (similarly to measuring the distance to the tree when measuring its height).

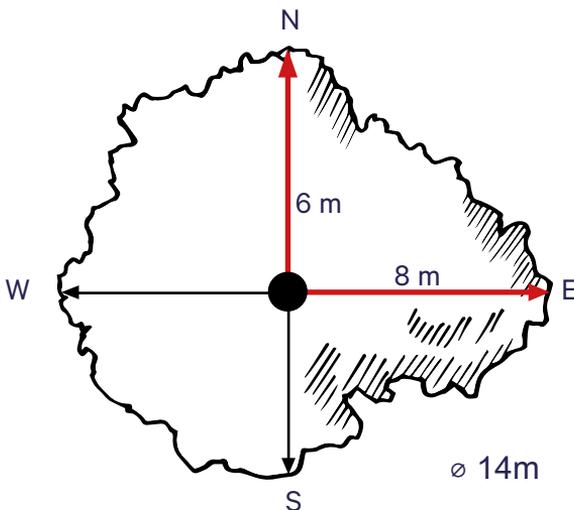


Figure 22a: Diameter of the crown.

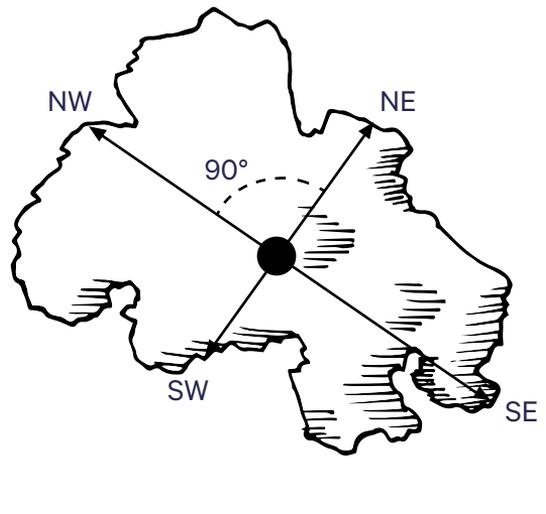


Figure 22b: Measurement of the diameter of a crown with high asymmetry.

### CROWN BASE

This parameter is not considered as a basic one in tree inventory. It is used exceptionally, e.g. for tree assessment (including advanced assessment) or to determine the impact of a tree on a planned construction project or of a project on a tree. This parameter can be used to assess the impact of the tree crown on clearance (e.g. roadway, pavement, track).

The crown base parameter is defined as the distance between the base of the trunk and the point of attachment of the lowest crown branch. Individual branches, especially adventitious ones, growing outside the contour of the main part of the crown, are not taken into account for the measurement. The permissible measurement error is due to the measuring device used. Measurements are given in metres and rounded off to the nearest 0.1 m.

Measurements are taken with instruments in the same way as for measuring tree height.

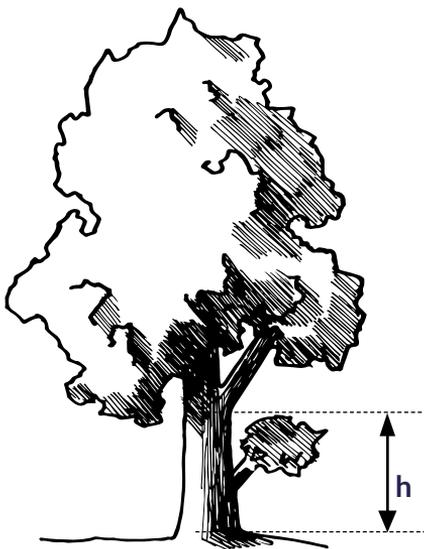


Figure 23: Height of the crown base.

### CLEARANCE HEIGHT

This is a parameter which is not a basic input for tree inventories. It is used exceptionally, e.g. for tree assessment (including advanced assessment) or to determine the impact of a tree on a planned project or project on a tree. This parameter can be used to assess the impact of the tree crown on clearance (e.g. roadway, pavement, track).

The clearance height parameter is defined as the distance from ground level to the lowest part of the lowest branch within the actual crown. The measurement is given in metres, rounded off to the nearest 0.1 m. Single branches, especially adventitious ones, growing outside the contour of the main part of the crown, are not taken into account for measurement.

Measurements are taken with instruments in the same way as for measuring tree height.

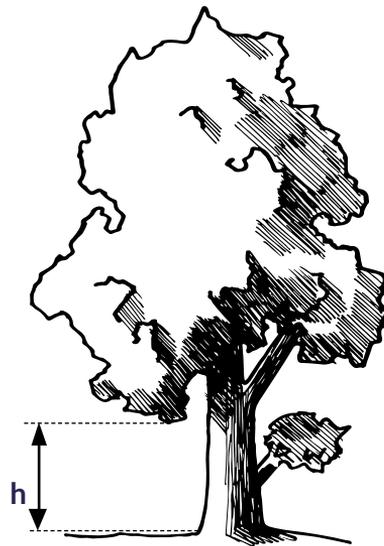


Figure 24: Height of the clearance height.

### CROWN HEIGHT

This is a parameter which is not a basic input for tree inventories. It is used exceptionally, e.g. for tree assessment (including advanced assessment) or to determine the impact of a tree on a planned project or project on a tree. The crown height parameter is the difference between the height of the tree and the clearance height. Measurements are taken in the same way as for the tree height and are rounded up to the nearest 0.1 m.

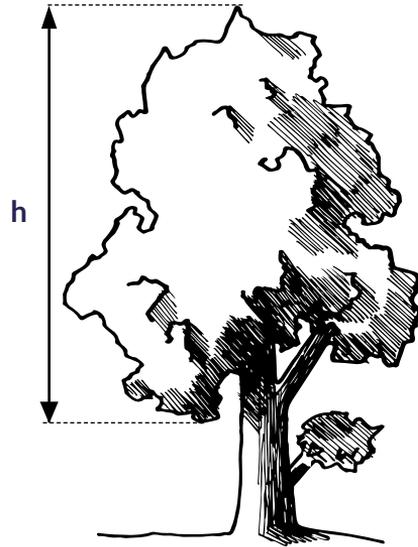


Figure 25: Height of the crown height.

### PHOTOGRAPHIC DOCUMENTATION

The easiest way to visualize a tree and its characteristics is to take a photograph. A tree inventory is usually not documented by photographs - it is not necessary. However, you may wish to take photographs. In this case, the photograph will include a view of the whole tree. If the contract states that in addition to the tree view (of the whole tree), the characteristics of the tree have to be recorded, photos of those characteristics should be taken (e.g. multi-trunk character, characteristic features of the trunk or crown structure or damage). In order to avoid assigning the characteristics you have photographed to another tree, take a series of photographs of each tree separately, so that the pictures do not overlap with photographs of other trees. Do not return to the previous tree once you have taken a picture of another one. Once you have photographed a tree and its features, before you start documenting the next tree, take a photograph which clearly indicates that the next photograph will be of a different (next) tree. When using arbotags, separate the photos of each tree (and its characteristics) with a photo of the arbotag, which records the individual number of the tree.



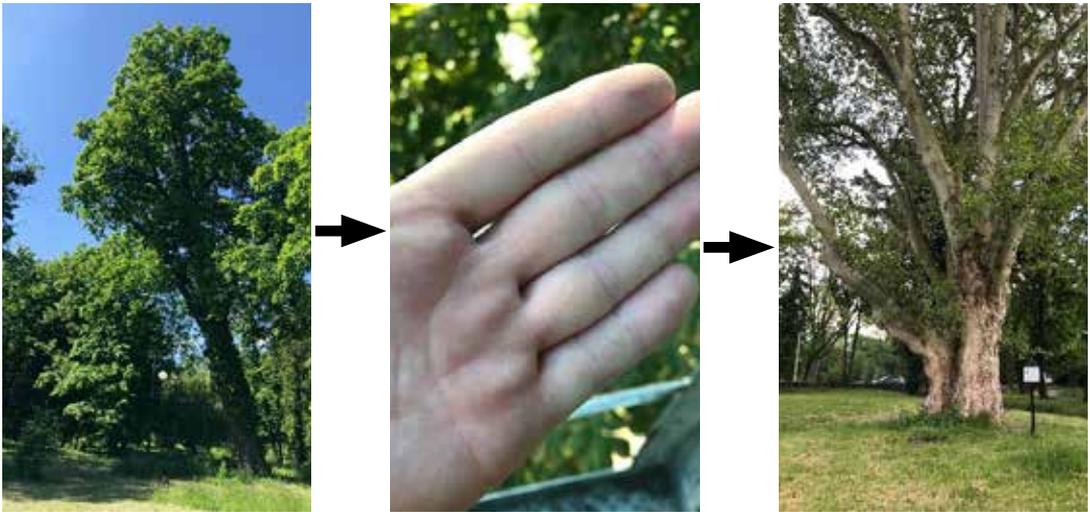


Figure 26a: Example of documenting with a picture (separate individual tree pictures with a picture of e.g. your hand).



Figure 26b: Example of documenting with a picture (separate individual tree images with a photo of e.g. an arbotag on the next tree).



## 5. PREPARATION OF THE DOCUMENTATION

Finished studies are usually prepared as digital version and submitted to the ordering party in a paper version and on digital data carriers (e.g. pendrive, CD/DVD, server). In the case of supplying the documentation on carriers, it is important to ensure that files are unambiguously named and carriers are described, which facilitates their archiving. The final compilation is carried out during the desk work, at the computer, when the data collected in the field are transferred "cleanly". It concerns mainly maps in paper versions, from which data has to be

transcribed into digital version in preparation for printing. Also data collected in the form of tables are transcribed and prepared for printing.

Both the preparation of the study for printing and the preparation of files and their transfer to digital data carriers can be time-consuming and generate costs (especially for the printing of the ready study) - the time needed for the preparation of the study and its cost should be included in the pricing of the task.

### TIP 6

The report from inventory should include: the title of the order, the ordering party, the contractor, the date of execution, the table of contents, and should bear the signature of the author.



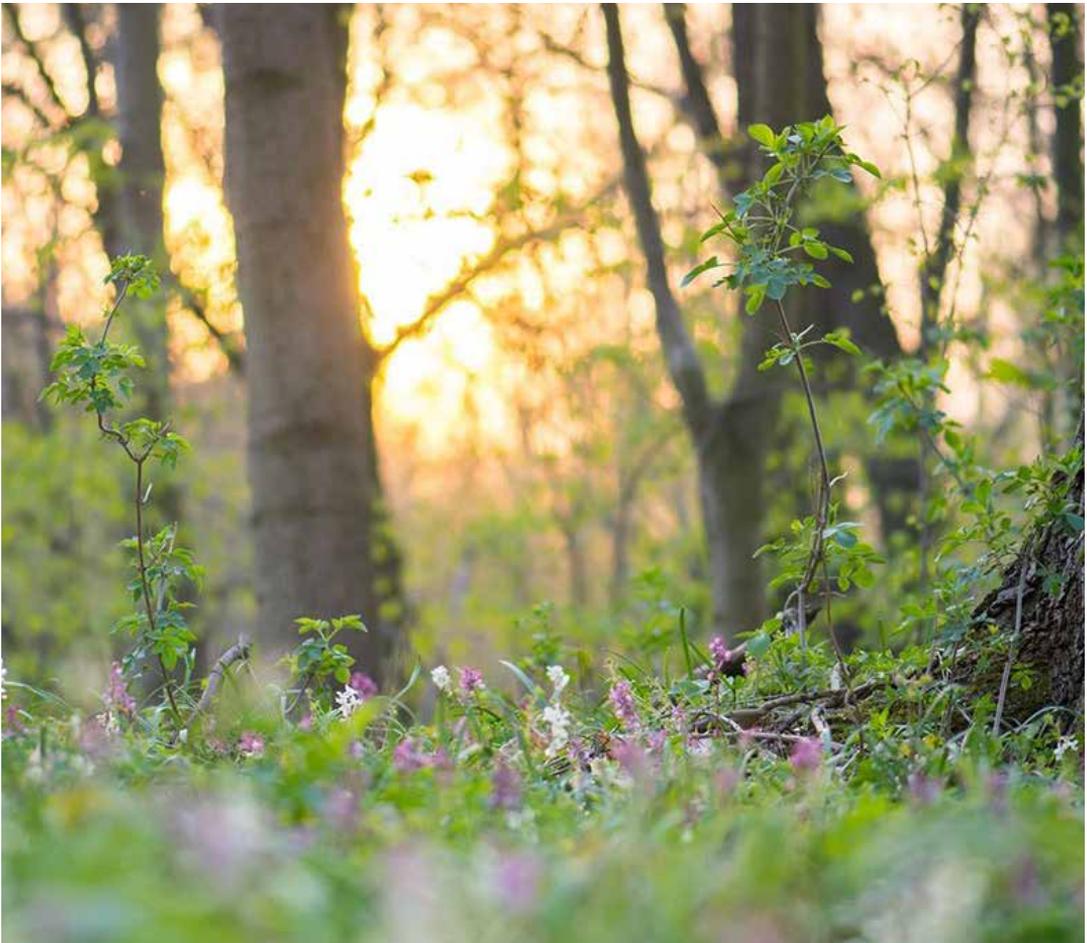
As a rule, the documentation should mention the name of the contractor and be signed by the author. The final documentation should be clear, legible and easy to use for the Contracting Authority and other recipients of the inventory. Typical elements that can be included in the survey report:

- **Title page:** author, contracting party, the object of the survey (name, location), deadline for completion,
- **Table of contents:** in electronic documentation - interactive, with page navigation
- **Introduction:** the purpose of the inventory, what data it contains, the area covered,

information about the author of the assessment, contact details,

- **Description of methodology,** tools used, data collected, explanation of terms used, if any, sources of data used in the inventory,
- **Inventory results:** usually in tabular form, as a compilation of field-collected data assigned to individual inventoried trees (with specific unique identifiers - numbers e.g. arbotag ID).

Documentation should be reliable, accurate and legible, and this should also be required of the way data is collected in the field.



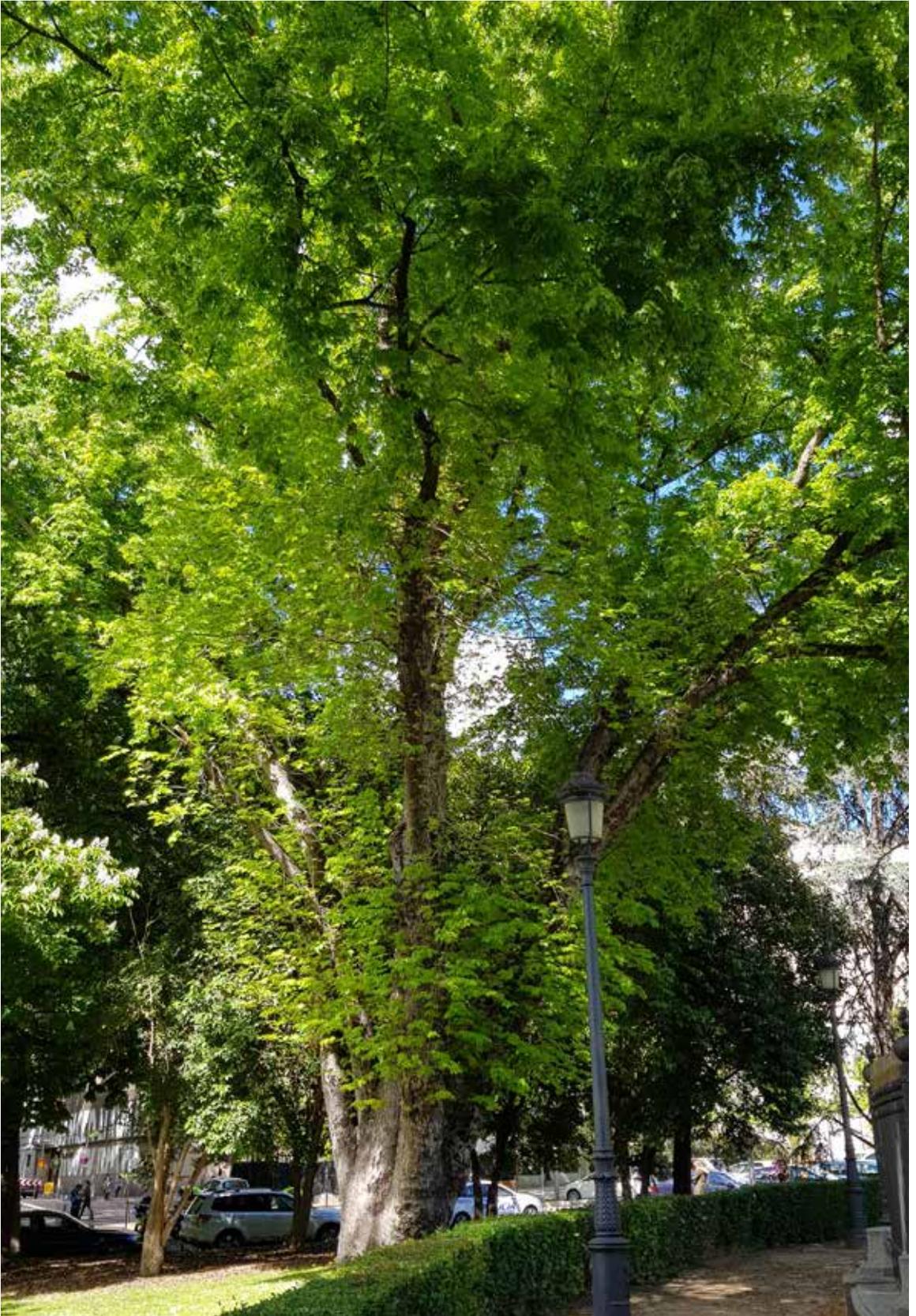
## 6. PASSING THE INVENTORY TO THE ORDERING PARTY

Before the documentation is handed over to the recipient, we need to make sure that we have completed it in accordance with the order (has been printed in the correct number of copies? properly signed? securely bound?) We deliver the documentation in a manner consistent with the order, and if the order does not specify it, in a generally accepted manner. In the case of local/ government administration bodies, to the so-called registration log (remembering to request confirmation of receipt of the documentation).

In other cases, by mail (registered letter or letter with return receipt). It is also possible to deliver the documentation in any other manner agreed with the ordering party, e.g. in person (remember to ask for a confirmation of the delivery of the documentation by making a relevant annotation on the copy to be kept in your archive).

### TIP 7

We shall always hand over the final report in a way that enables us to prove that we have delivered it to the recipient and that this handover took place on the specified date.



## *II.*

# *Marking trees on maps and in the field*

### **FROM THIS CHAPTER YOU WILL LEARN:**

- Why and how trees should be marked on maps
- What tools can be used to plot trees on maps.
- Which base maps can be used to plot trees
- Why and how to mark trees in the field

## **1. INTRODUCTION**

One of the basic parameters for the identification of a tree is its location in space through mapping. This makes it easier to identify the tree in the field (and to return to it later, for example). The way in which trees are marked on maps may be defined by the assignment, but also by national

legislation. The use of arbotags on tree trunks is not required, but recommended, in order to be able to quickly identify the desired tree later on (if it has been marked / inventoried beforehand). The arbotag on the tree must have the same number/identifier as the tree on the map.

Figure 27: Typical elements of the tree marking process.



## 2. TOOLS FOR PLOTTING TREES ON MAPS

The most commonly used tool for marking trees on maps is still in most cases a printed map on which a tree is manually drawn (Fig. 29). The most accurate map underlay is the base map, which is recommended for use. Another used base is the orthophoto (a map in the form of an aerial or satellite photo). Due to the lowest accuracy, the land register map is not recommended for use.

Another method of plotting trees on maps, which is currently being developed and more widely used, offer various applications for portable electronic devices (e.g. tablet). This is a convenient tool, as it allows uploading any map base, finding oneself in the field with the use of GPS. It allows to avoid manual transfer of the field data during desk work, as it is the case with paper maps. It should be noted that there is no unified system or standard of using a given application/software for tree inventory (plotting on map bases), so creation of a widely available (global) database of inventoried trees does not seem feasible.

Considering the rapid technological development, including surface scanning methods such as using drone, photogrammetry, LiDaR etc., plotting of trees on base maps may be realised in the future in a relatively short period of time. These methods may have their limitations, e.g. due to the challenge to distinguish undergrowth or competing trees, so regardless of the method used, additional field work should be carried out. Aerial mapping methods are particularly appropriate for investigating tree health (e.g. effects of drought or quantifying the potential for spread of pests or pathogens) identified by thermal or IR scanning.



### 3. MARKING TREES ON BASE MAPS

We do this when the client or the nature of the work does not require the use of geodetic location of trees on base maps. The plotting of trees on maps can be done either by marking a point on a printed map or by marking a point in an application. It is important to remember that the marking of the inventoried tree takes place in the field, but depending on the tool used to carry out the inventory (paper map or application), it may also be necessary to transfer this datapoint later (during fieldwork) to the bases of the final documentation.

When a contract requires the surveyor to plot the inventoried trees on a map, base maps will always be used (Fig. 28). Depending on national standards, trees may be marked on the map by the surveyor in the form of a dot in the middle of the tree trunk, as well as a mark to distinguish between deciduous and coniferous trees (Fig. 29). In cases where no geodetic mapping of the inventoried trees is required, the recommended map is the base map, as it contains the most details and thus allows a fairly accurate mapping of the inventoried tree (Fig. 30).

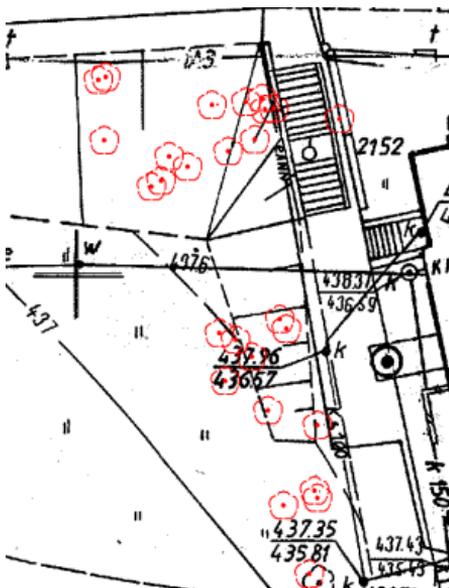


Figure 28: Base map with geodetically marked trees.

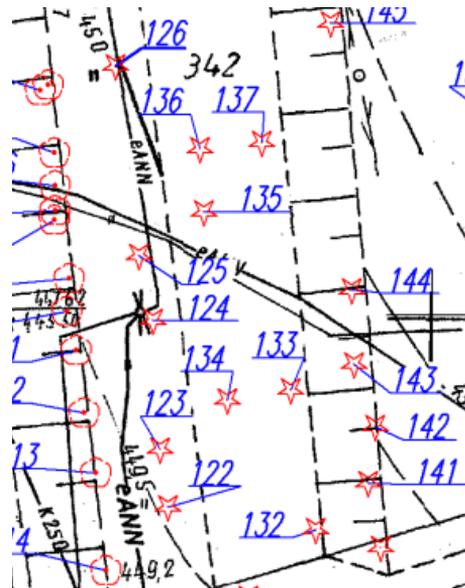


Figure 29: Base map with geodetically marked trees and unique tree identification markings.

In cases where trees in the area grow in rows, avenues or are sparsely distributed in the inventory area, orthophotos can be used. However, the use of orthophotos in dense stands may generate errors due to incorrect locating of the inventoried tree and thus problems with finding it later in the field. Mapping trees with the use of electronic tools (e.g. tablets) in dedicated applications on orthophotomaps can be helpful as it uses GPS. This allows us to easily find the inventoried tree and mark them on the map in the application. It eliminates the need to plot again the location of the trees during desk work to the final documentation (just print the map from the app). In addition to locating the tree on the map, a unique number must be assigned to it. In cases where dimensions of the inventoried trees indicate that a permit for their removal is not required (based on country-specific legislation), the location of these trees (after agreement with the client), need not be marked as individual trees, but as a group of trees. If requested by the client, the final report may also include the actual extent of the tree's crown (diameter) in addition to the tree designation on the map (Fig. 31).

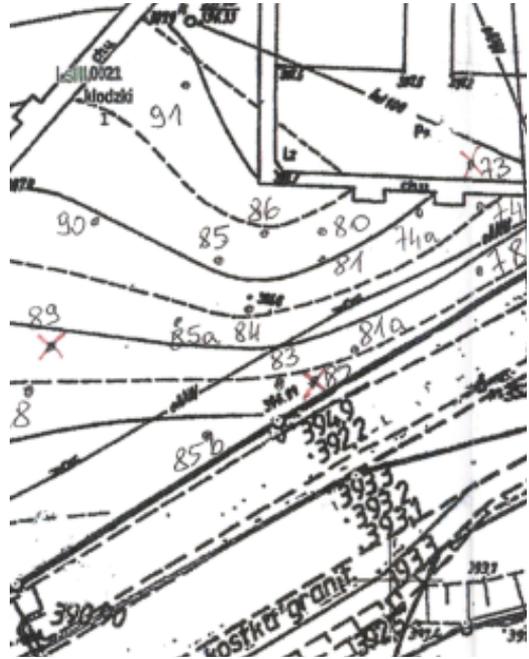


Figure 30: Base map with manually plotted trees and assigned tree identification.

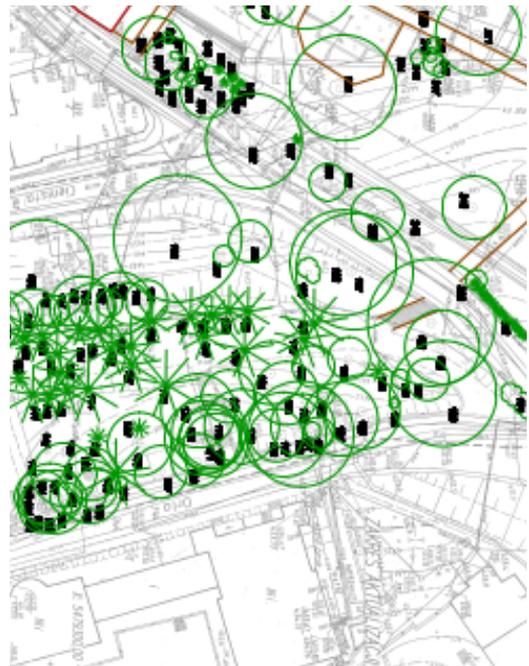


Figure 31: Base map with trees and their crown extent plotted.

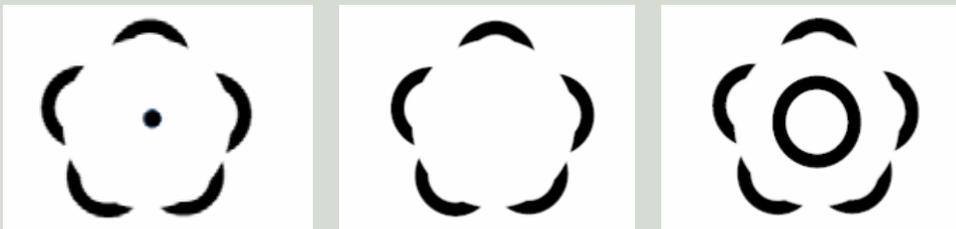
**TIP 8**

If you have received a map with surveyed trees, coniferous trees will be marked with a symbol:



*Figure 32: From left: conifer tree located geodetically, conifer tree – not geodetically located, conifer tree - located geodetically - nature monument.*

and deciduous trees with the symbol:



*Figure 33: From left: deciduous tree located geodetically, deciduous tree – not located geodetically, deciduous tree - located geodetically - nature monument.*

If there is a dot inside the symbol, this means that the tree was marked via geodetic location of the tree. If there is no dot inside the symbol, it means that the tree was marked as an approximation without geodetic location of the tree.<sup>5</sup>

<sup>5</sup> e.g. in Poland regulation of the Minister of Development, Labour and Technology of 23 July 2021, (Journal of Laws of 2021, item 1385) on the database of topographic objects and the master map. Appendix No. 4 - Technical standards for the creation of the principal map, including the scope of its content for individual scales and conventional signs.

## 4. TAGGING TREES IN THE FIELD

The purpose of physically marking trees in the field, by attaching a label containing information about the tree, is to facilitate its later identification.

At the turn of the 19th and 20th century, metal number plaques were used to mark trees. The development of technology in this area has brought about new solutions and nowadays, most commonly used are arbotags, i.e. plaques with a number on them, e.g. a sequence of digits (Fig. 34). These tags can be unique not only for a particular tree, but also for a particular site/area/space. It is important to ensure that the tags contain identical information with the tree description on the map.

Guidelines for tree tagging may vary from municipality to municipality, region to region, country

to country, which may be due to legislation or local by-laws, so the tree tagging requirements (if any) should be reviewed in advance.

Depending on the purpose it serves, e.g. current tree maintenance, tree removal, inventory or planning or design studies, different tree marking methods can be chosen. Arbotags vary in size, shape and colour, but also in the data they carry. A series of digits (identifying the tree) can be supplemented with a code of region / area / municipality. A barcode is also an option. In combination with a barcode reader and an appropriate application, it allows to quickly read the information (collected earlier) about a tree when it is re-inspected.

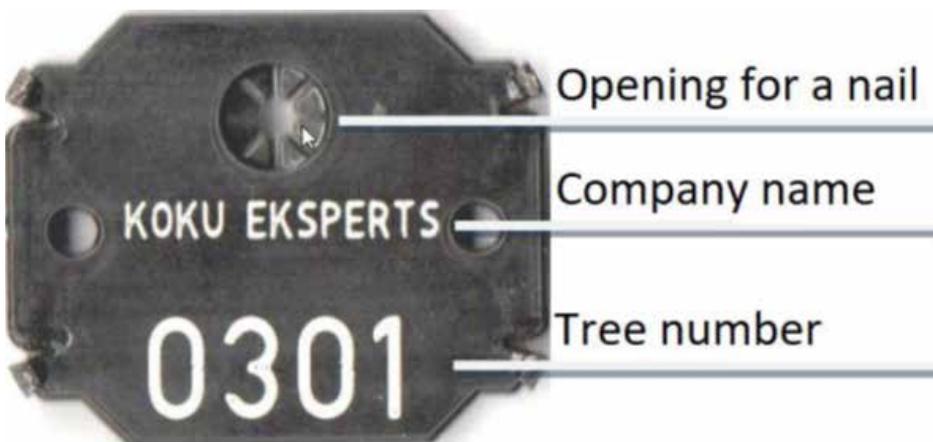


Figure 34: Example of an arbotag. (Source: [http://site50010.mozfiles.com/files/350010/Koku\\_novertesa-nas\\_manualis\\_2019.pdf?1557811335](http://site50010.mozfiles.com/files/350010/Koku_novertesa-nas_manualis_2019.pdf?1557811335))



Figure 35: Tree marking kit. (Source: <https://americansignumat.com/products/arbo-tag-tool-set-2>)

Most commonly, the tags are installed on a single pin/nail (Fig. 36), which is driven into the wood, while keeping a distance that allows the tree to grow in thickness (recommended to be at least 3 cm, optimally 8 cm). The nails used for marking are made of galvanised steel to prevent corrosion and have a smooth surface to minimise possible mechanical damage to xylem and phloem. In addition, the depth of the nail driven into the tree trunk should be no more than 1 cm into the xylem (so as not to disturb the heartwood and thus the potential negative impact of pathogen colonisation). Due to the risk of vandalism, the tag should be mounted at a height of 2-2.5 m, in such a way as to allow its unobstructed reading but make intentional destruction difficult (Fig. 37). Tags should be durable, legible and weatherproof.



Figure 36: Fixing the arbotag to the tree trunk with a nail. (MK)

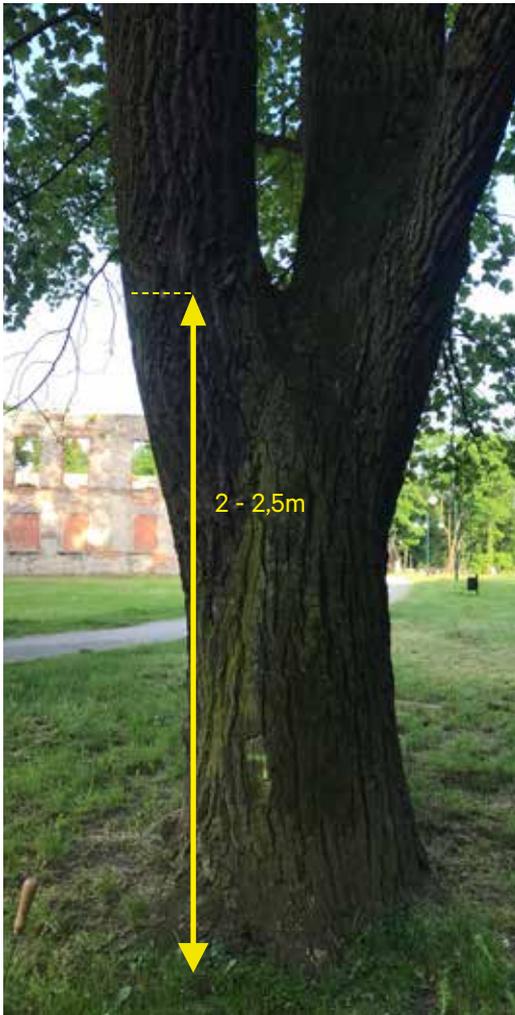


Figure 37: Mounting height of marker (arbotag) from 2 to 2.5m. (MK)



Figure 38: Acceptable paint marking on the trunk of a tree whose removal has been authorised. (MK)

Exceptionally, trees can be marked on the trunk with permanent paint (Fig. 38), but only with the agreement of the client, in cases where the removal of the tree has already been approved (administrative decision).

Not all trees are suitable to be nailed (e.g. in the case of fast growing young specimens or trunks that are too thin, which can cause the trunk to break when nailing). Sometimes you should also take into account negative public opinion about nailing to tree trunks. In such

cases, for example, metal expandable springs can be used instead of nails, which stretch as the trees grow in thickness (Fig. 39).

A completely harmless fixing method is to place the label in the ground at the base of the tree (Fig. 40). However, such attachment methods are considered more susceptible to vandalism and can be used to a limited extent, e.g. in supervised and enclosed sites such as botanical gardens etc. When tagging young trees, it is recommended to use temporary labels, attached only to the



Figure 39: Attaching a marker to a tree trunk using a stretchy metal spring that extends as trees grow in thickness. (Źródło: <https://i.pinimg.com/564x/5f/09/17/5f091787499faaf96cd1b3c483711d7b.jpg>)



Figure 40: A label driven into the ground at the base of a tree. (Source: <https://www.nationalband.com/arboretum-tags/#top>)

bark, with a band around the branches or on stakes stabilising the planting (Fig. 41).

If temporary tagging is needed and sufficient, labels (tags) can be made from cardboard, for example (Fig. 42). It is not acceptable to nail

tree markers to the trunk of young trees, as this can cause the tree trunk to break (Fig. 43).



Figure 41: Temporary marker (arbotag) mounted on a young tree using a branch tie. (MK)



Figure 42: Example of a temporary caron label attached to a stake stabilising a young planting. (Source: <https://www.kiwilabels.co.nz/our-labels/nursery-labels-and-tags/>)



*Figure 43: Incorrect installation of a marker with a nail on a young tree. (MK)*

## TIP 9

The use of an application and orthophotos, helps to identify the tree in the field and on the map more quickly, but if you are working in a dense stand, this can be significantly more difficult due to the inaccurate GPS measurement (usually with an accuracy of 4-15m). The use of orthophotos is easy in the case of rows and avenues of trees, and when the trees are not very dense (when the position of a particular tree can be determined with certainty). The use of paper maps increases the work time, because it is necessary to make a description on the map in the field and to mark the map later in the final documentation when working on the results during the desk work. The most accurate method of locating trees on a map is by taking appropriate instrumental measurements by a surveyor.

Arbotags (tree markers) make it easier to find trees in the field, which speeds up work. You can use diverse types of tags (metal, plastic or even temporary cardboard tags), which can be attached to the tree in diverse ways (nailed to the trunk, mounted with bands or springs around the trunk/branch, temporarily mounted with bands around the branches of young trees, or driven into the soil near the tree).

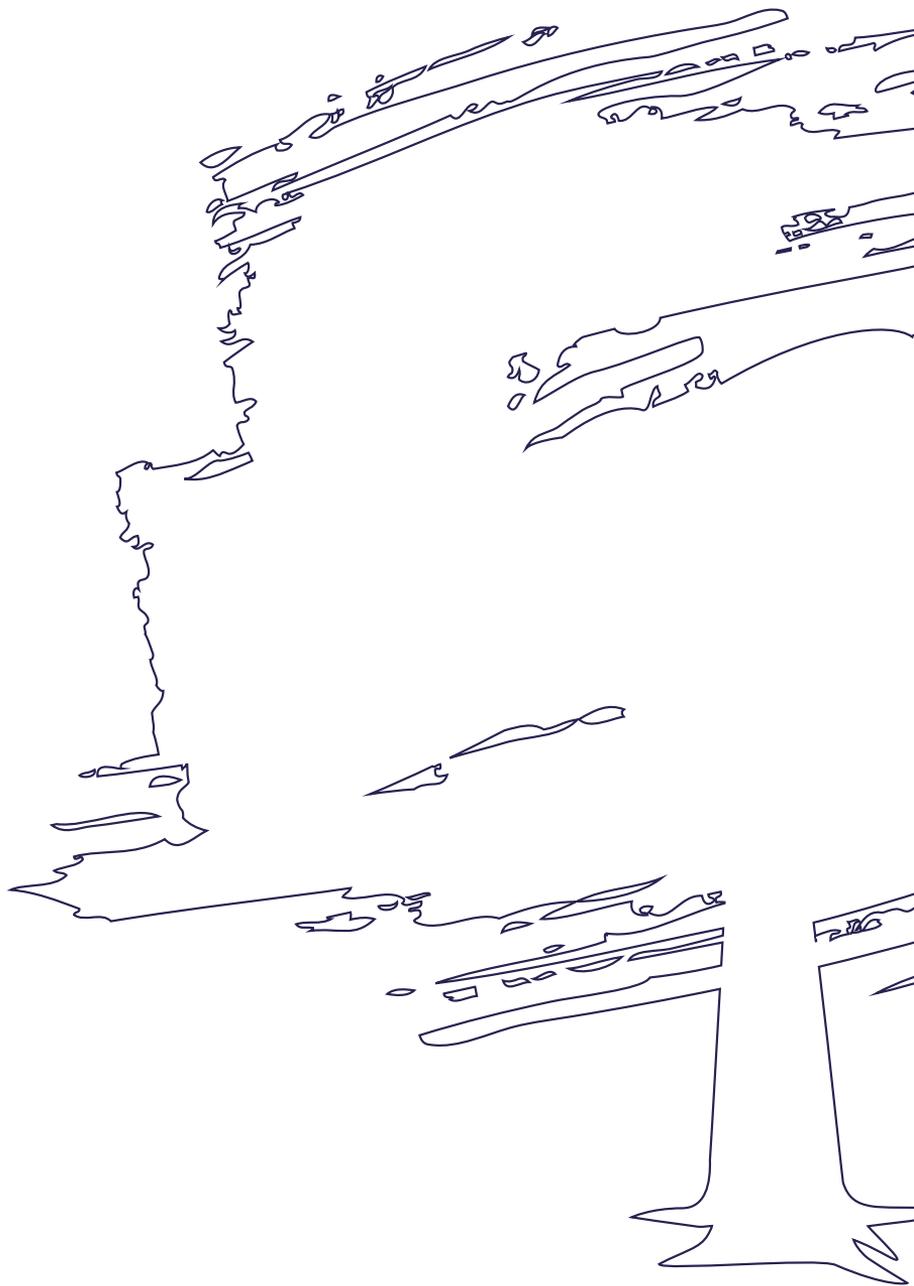


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# *Notes*



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