Commercial Trees. Text: Fernanda Coelho

Why monitor trees of commercial interest?

Commercially viable trees are a good group for monitoring because they allow you to estimate the potential economic value of the sampled area. In addition, the survey can be used to assess environmental impacts because this group of trees is a good indicator both for altered areas and for forests where there has been little disturbance. Non-timber species can also be greatly affected by logging, climate change and other human interventions. However, it would be very difficult to survey all the non-timber species because of the great difficulty in obtaining the reproductive material (flowers, fruit etc) that is necessary for identification. In time, it is expected that all the trees in the RAPELD modules will have been surveyed, but this is not a feasible short-term goal.

How is RAPELD structured?

The RAPELD modules consist of standardised trails and permanent plots. The map shows a grid and lines which represent trails, which usually are 5 km long and 1 km apart from each other. (Fig.1).

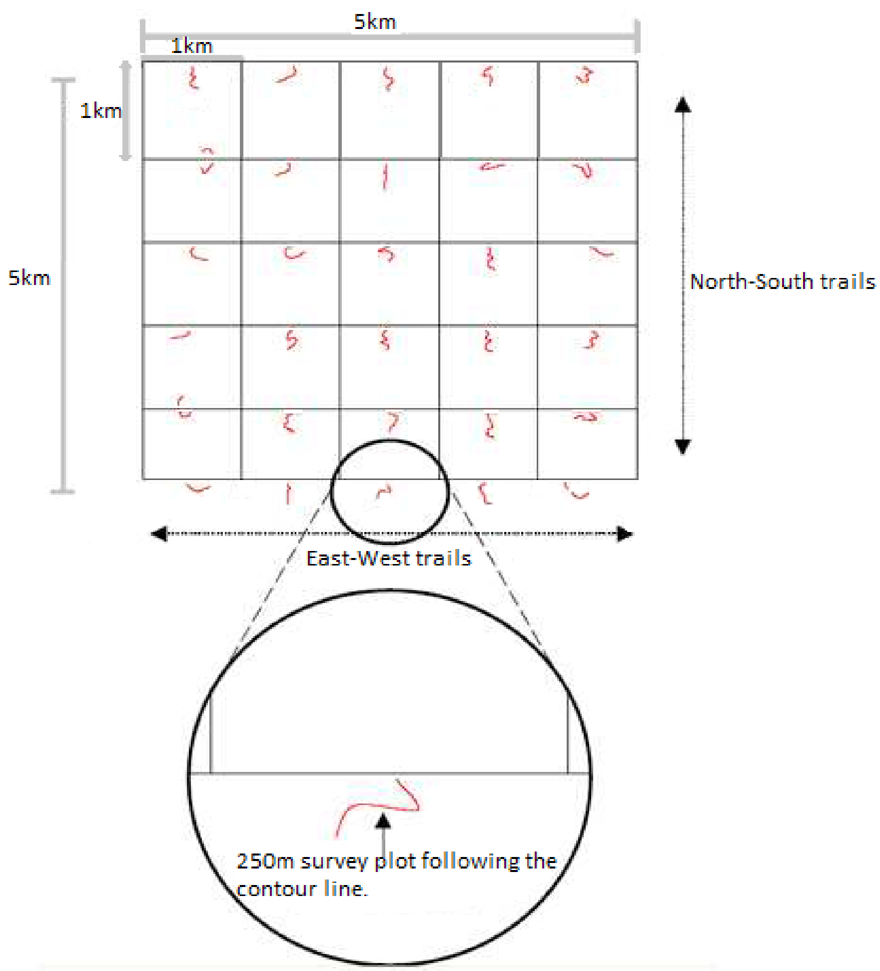


FIGURE 1. Diagram to illustrate the structure of a standard RAPELD grid.

The trails (Figure 2.) are marked with a picket (Figure 3.) every 50 meters with the trail name and the distance along the trail (Figure 2).

Figure 2: Example of a trail marked out by pickets.

Figure 3: Example of a picket tag showing the trail name and distance along the trail (3000m).

Surveying.

The are a range of different standardised plots for different organisms to be surveyed.

- uniformly distributed standard plots for terrestrial organisms
- riparian plots
- aquatic plots
- linear trails

The density of trees can be measured on standard plots, but since most species of trees are represented by only a few individuals, it is difficult to obtain a valid representative sample. Better to use a trail as a transect line which can cover 10s of kilometers and thus provide a better sample.

The sampling trails are of fixed length, usually 5 km, and a variable width which depends upon the detectability of the species and the observer's detection ability; the area is not fixed.

To locate, measure and identify the trees, you must have the following materials:
- Machetes,
- Camera,
- Binoculars,
- Two 50 m tape measures,
- Tape or diameter tape,
- 1.3 m stick,

- Pencil, eraser, sharpener, clipboard, plastic bags to protect the clipboard
  - Field guides or cards for identifying the species to be sampled
  - It will help you a lot if you take a map of the grid or module and the survey area.

Before going to the field make sure you fill in the metadata spreadsheet that contains information describing the data, without these the data has no value, regardless of the storage system. Metadata records should contain the team information (who),when (time and date) and where (geographic coordinates) how, (the method of data collection) and the attribute table information.

The correct documentation in the form of metadata associated with field sheets ensures that the survey can be replicated, found and understood and used effectively with the data sets that are generated and made available.

Worksheets to record data and metadata are available on the PPBio website and follow the most widely used protocol Ecological Metadada Language (EML) developed by the Knowledge Network for Biocomplexity (KNB).

Field Guides.

When these trees are not in a reproductive state they can be very difficult to identify, even by experts and qualified taxonomists. The types of roots, stems and bark can obtained from various literature sources and taken to the field in the form of laminated cards . These guides used must also be described in the metadata records.

In Amazonia, the "Flora da Reserva Ducke"(Ribeiro et al., 1999) can be used to identify widely distributed species.

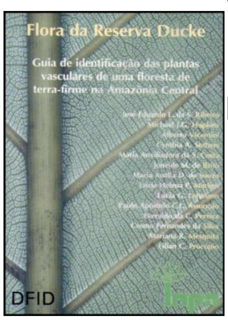


Figure 4: Plants of the Ducke Reserve.

However, for surveying and monitoring commercial species, it is essential to include a botanist on the team who has expertise in this area.

In the Acre region the "Guia Illustrado e Manual de Arquitetura Foliar para Especies Madeireiras da Amozonia Occdental. "(Obermüller et al., 2011).

Figure 5: Illustrated Guide to the leaf architecture of Timber Species in Western Amazonia.

To survey and monitor vegetation requires two people, one observer and a note taker.

1. The observer is responsible for identifying, measuring and putting nameplates on the sampled individuals.
2 .The recorder measures the distances along the track and the perpendicular distance to individuals of interest and records the data on to the field sheets.

To measure the distance along the trail (Y) a tape measure must be stretched between both pickets of a 50m section.. Sampling should begin at the "0" picket. Secure the free end of the tape measure with a small stick that can be pulled from the ground when the next section is ready to be measured. This will save you from having to walk back to the beginning of each measured section.

The Y position is recorded in meters from the start of the trail, not from the beginning of each section. You must walk slowly and at a constant speed along the trail, until the observer finds a timber tree with a diameter ≥ 10cm DBH. The recorder should not participate in the search for trees and should never "correct" observer by adding trees that the observer did not see. Adding trees not detected by the observer changes the detection curve along the trail and invalidates the estimated density using the line transect method.

When you find a tree, the recorder measures the perpendicular distance of the tree from the trail with the tape taut and records it on the spreadsheet as distance X (Figure 6).

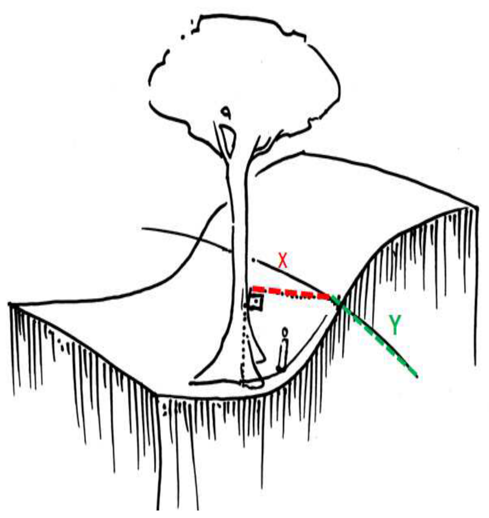


Figure 6: Measure the perpendicular distance to the tree (X) and the distance along the trail (Y).

Design: Karl Mokross

When measuring a tree's diameter, use a stick of 1.3 m length (≡DBH) to ensure that all the trees are measured at the same height.

- The observer measures the diameter of the tree 1.3 m above ground if the trunk is relatively uniform (Fig. 7a).
- Slanting trees have the diameter measured at 1.3 meters above the soil, following the slope of the tree (Fig. 7b).
- When the tree is on sloping ground, measure the diameter on the higher side (Fig. 7c).

– Where both the ground and tree are inclined, the diameter must be measured at 1.3 m above the ground following the angle of the tree, from the highest side (Fig. 7d).

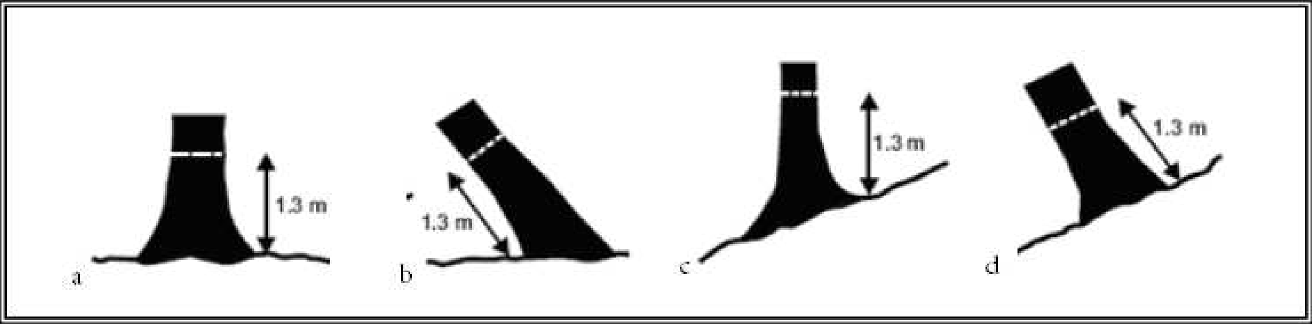


Figure 7: Points of measurement of diameter. a) Flat, vertical tree, (relatively uniform); b) inclined tree on flat terrain; c) vertical tree on sloping ground; d) Both tree and terrain at an angle.

When measuring the circumference, make sure the ribbon is taut and horizontal. It may be necessary to remove loose bark, lichens and mosses. However, you should never remove hemiepiphytes or cut lianas. Just push them to one side so that you can pass the tape around the tree.

– If the tree has an injury, lumps, callouses or any other deformity at 1.3 m, the point of measurement (POM) must be moved to above the defect, where the trunk is normal. This new POM must be recorded on the worksheet (Fig 8a).
– If the tree has adventitious or buttress roots, the new POM is 1 m above them (Fig. 8b, c).
– Trees with a fork at 1.3 meters above the soil are measured 20 cm below the bifurcation (Fig. 8d).
– For trees with a bifurcation below 1.3 m the diameter of each branch is measured separately at 1.3 m above the ground (Fig. 8e).

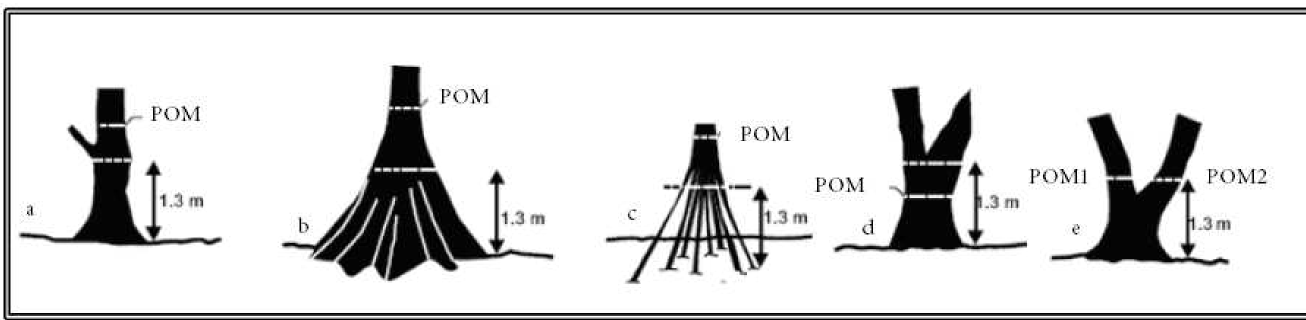


Figure 8: New Point Of measurement (POM). a) Tree with injury, wounds, nodules or any type of deformity; b) tree with buttress roots; c) adventitious roots; d) tree with fork; e) tree with bifurcation below 1.3 m. In each case the new POM must be recorded on the worksheet.

The main objective of this survey is to determine the density and spatial distribution of timber species in order to estimate the economic potential of the area, and identification using common names is sufficient. If the only objective was to estimate the timber value of the forest, our work could end here. However, according to CONAMA (the Brazilian Environmental Council) resolution 406/2009 Article 20, "it is necessary to adopt technical and scientific procedures to identify managed forest species, to ensure conformity between their scientific names and their common names."

To regulate logging a mandatory licence, the Document of Forest origin (DOF) controlling the transport, and storage of forest products and by-products of native origin was set up by Decree of the Ministry of the Environment. Using the DOF system it is possible to link common and scientific names. However, the same common name applies to different trees or species, depending on the region and/or the identifier. The use of these names by experts and "woodsmen" in the identification of individual trees has been one of the main causes of the grouping of different species with the same vernacular name (Martins-da-Silva 2002) This may result in over-exploitation and the consequent extinction of some species. Currently, one of the biggest problems in forest management is the quality of botanical identification.

Forestry research on wood marketed under the name “Tauari” revealed that the name is applied to 5 different species (Procopius and Secco, 2008) and for “Cumaru”; two distinct genera belonging to five species (Sousa et al., 2007).

Several problems arise because of this inconsistency in the names recorded in the field, which is mainly due to the translation of popular names into scientific ones. It generates an accumulated error which can exceed 70% (Obermüller, com.pess). To minimize these errors, the work of associating the scientific names with common names can be done post-field with the help of the expert bushman (generally someone who is native to the area) or “parabotânico” that accompanied the survey, taking note of the regional variations that can occur in the common names for the various species.

Species identification

The identification performed in the field by an experienced bushman is sufficient for calculating the density of trees and estimating the economic potential of the area. However, for studies that focus on the conservation of species, an extra effort to collect material for a more accurate identification may be necessary, and needs research. That is why, we will record data on the worksheet that can be used to verify the identity of the tree.

A combination of the characteristics of the tree will aid in their identification. So you need to pay attention to features of the roots, trunk, inner bark and leaves. Observations of the characteristics of leaves may be limited due to the height of the canopy which may be 30-40m. Thus, the trunk is used as a key characteristic for the recognition of *Leishmania* species. The alternative is to look for leaves on the ground, but you must check that the leaf belongs to the tree that you want to identify and this may require binoculars.

To see the characteristics of the bark, it is necessary to make a cut in the trunk. We must ensure that we don't do more damage than necessary to these individuals. It is recommended that you use a special paints to cover up the wound made in trees to reduce the likelihood of infection by microorganisms.

To fill in the identification form, there are technical terms that are used to characterize the trunks and leaves. Illustrations and definitions of these features can be found in the literature, as in "Flora of the Ducke Reserve - Guide to identify the vascular plants of upland forest in Central Amazon which available at:
http://brahms.inpa.gov.br/bol/PFRD/GroupResources/Index.

When you are completing the form, watch out primarily for field information: the trunk, bark and leaves may have fresh, living features that cannot be seen in the dry material of the herbarium.

The trunk base is one of the features that can help in the recognition of families, genera or even species. They are commonly classified into straight (no expansion in base), dilated (thicker trunk close to the ground) and finger-like (with dilated small projections, roots in the form of "fingers") (Figure 9).

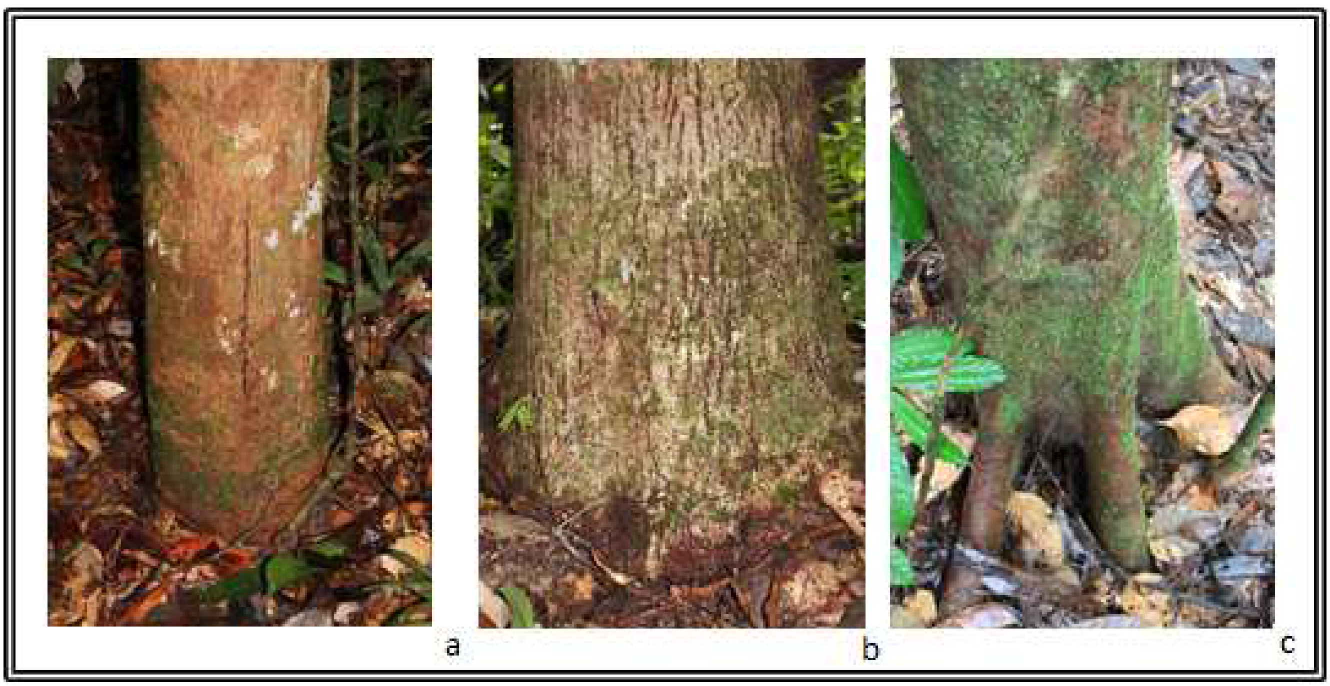


Figure 9: Basic Base Types, a) straight base; b) dilated base; c) finger-like (digitate) base.

Another important character is the presence of surface roots that can be flattened, known as buttresses, and common in Elaeocarpaceae, Fabaceae, Sapotaceae amongst others; or thick and visible on the ground over long distances. Of types of roots, the most common in trees typical of flooded forests or waterlogged areas are the anchor roots, which leave the stem and reach the ground and are present in many species of Clusiaceae; and adventitious roots which leave the trunk and do not reach the ground and are observed in some palms (Figures 10 and 11)

Figure 10: base types, a) buttresses; b) adventitious roots

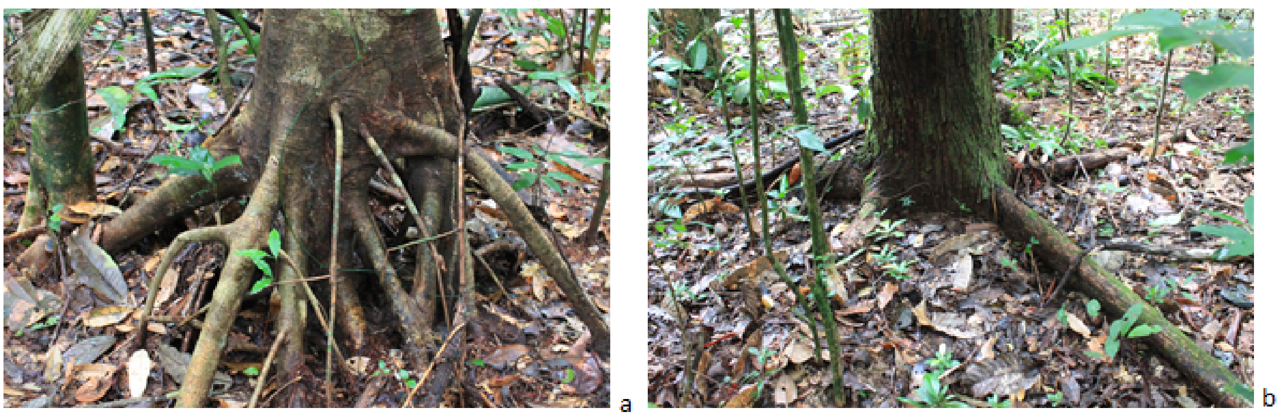


Figure 11: Basic Root Types, a) anchor roots; b) shallow roots.

The shape of the stem (Figure 12) may vary from circular, to slotted (irregular horizontal section), or fenestrated (with deep cavities or holes) or crested with projections in the form acute longitudinal ridges. These characteristics may indicate to the observer the possible family to which the tree belongs, or even the species, as is the case with *Ocotea olivacea*, the only species with a crested trunk found in Ducke Reserve.

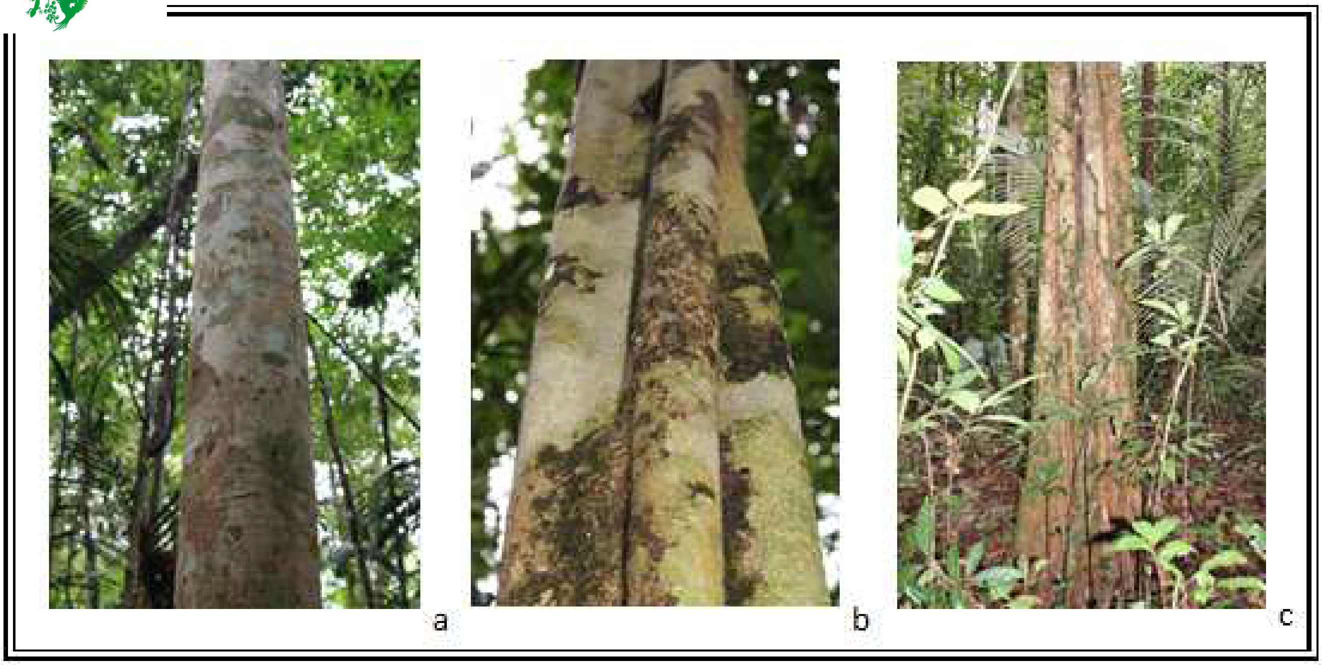


Figure 12: trunk shape, a) cylindrical; b) slotted; c) fenestrated.

The rhytidome or outer bark (Figure 13) of trees is difficult to classify due to the huge variation seen in the field. The Reserve Ducke guidebook, illustrates and describes the commonest features amongst species which helps to classify many types of rhytidome. According to the terminology used by the guide, the rhytidome can be classified as smooth; rough; dirty and rough; with large woody plates; with depressions; laminate; squamous; reticulated; fissured; striated; blistered/"lenticelated"; with spines or thorns.

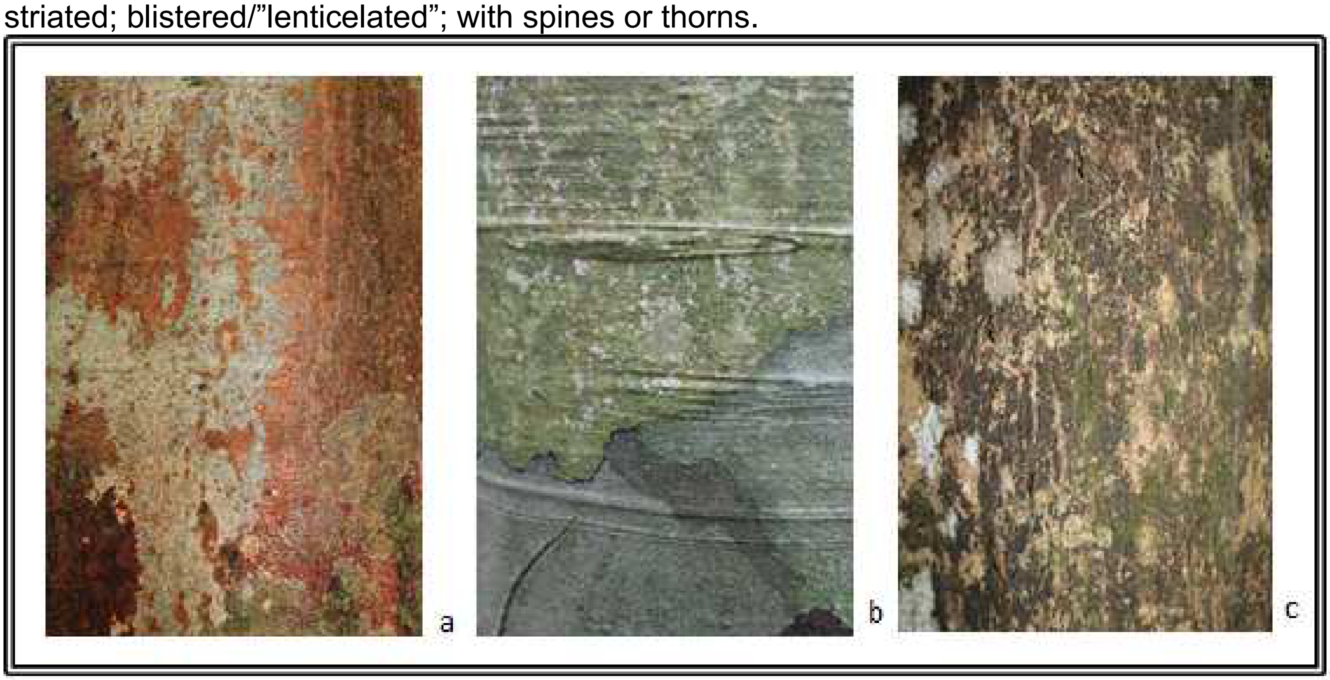
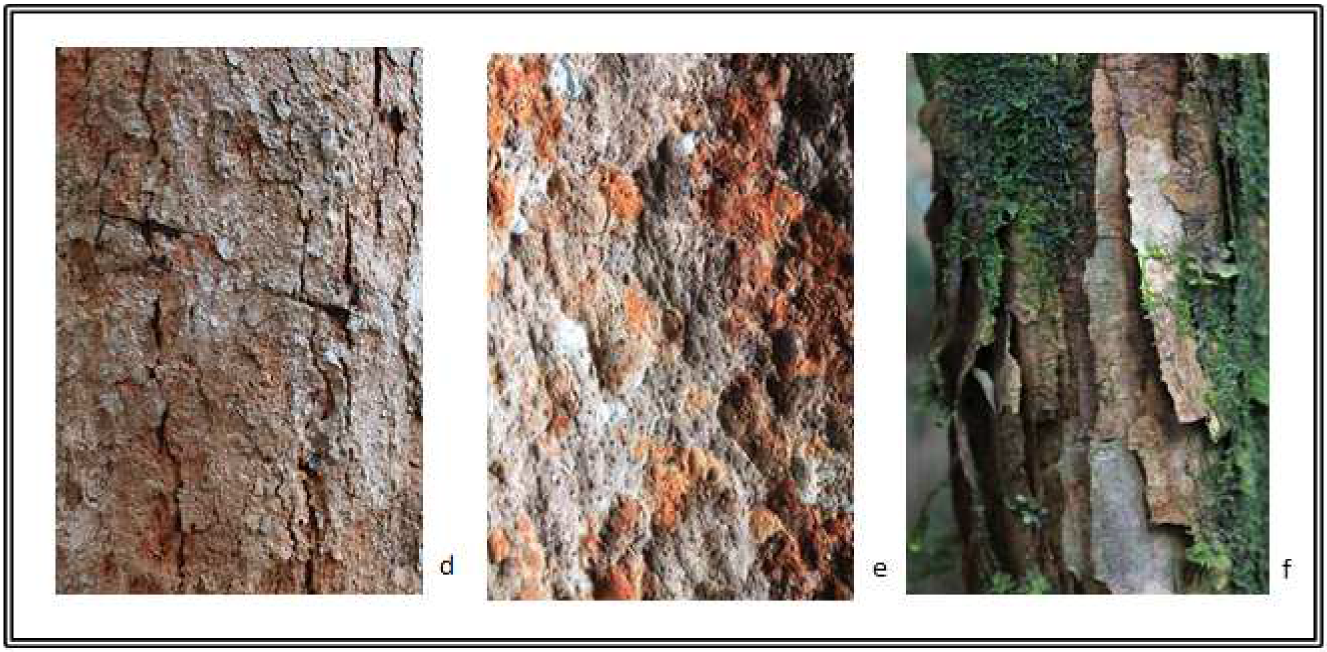
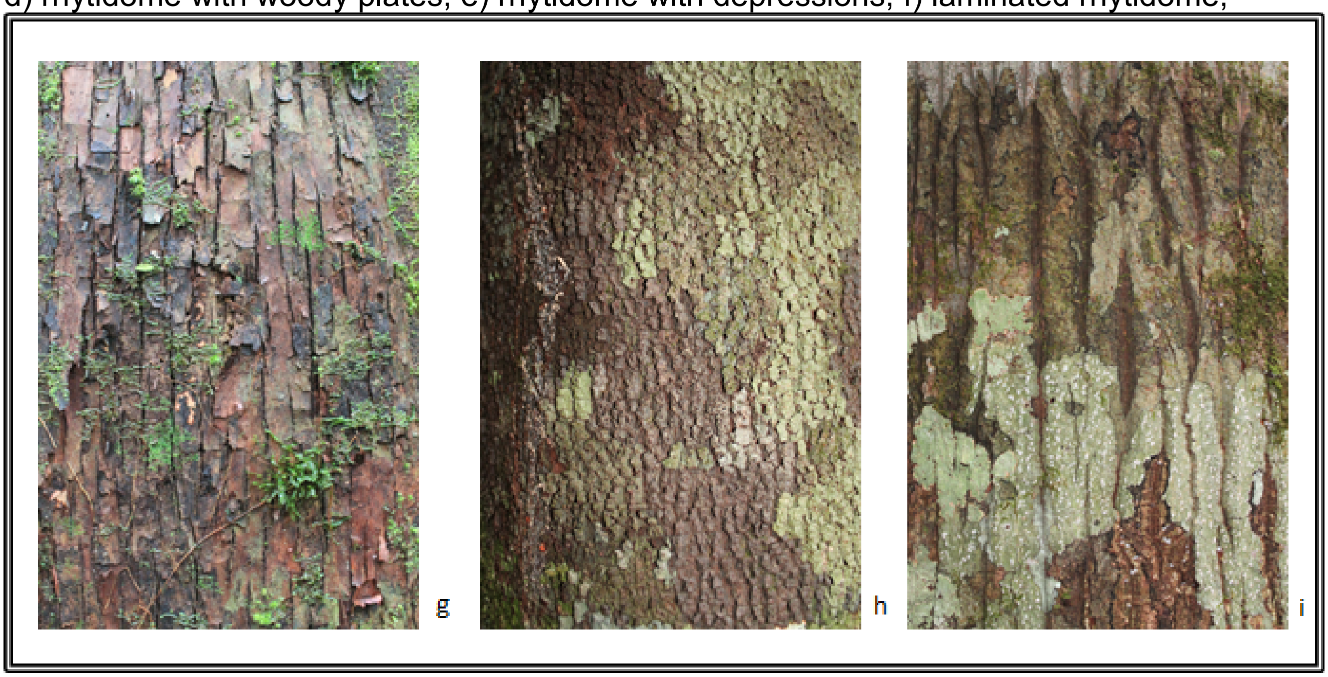


Figure 13: Types of rhytidome a) flat/smooth rhytidome; b) rough rhytidome; c) dirty or rough rhytidome.



d) rhytidome with woody plates; e) rhytidome with depressions; f) laminated rhytidome;



g) squamous rhytidome; h) crosslinked rhytidome; i) fissured rhytidome;

j) striated rhytidome k) blistered rhytidome; l) rhytidome with thorns

The rhytidome is also characterized by its color, generally ranging in tones of brown and grey. This can be a very useful feature when used in conjunction with other characteristics. I.e., the species *Peltogyne paniculata* Fabaceae (Purpleheart, Amaranth, Nazareno, Violetwood) of commercial interest, recognized by the presence of a smooth and completely red bole.

Features of the living bark also provide important information for identifying species. Among them, we highlight the presence of exudates, odors and stains. The exudates are: latex, gum, sap and resin.

Latex is defined as an opaque viscous emulsion insoluble in water. The colour of latex can vary and distinguishes families and genera, such as orange latex in the genus Vismia sp. (Clusiaceae), yellow in Calophyllum sp. (Clusiaceae) and light brown in Brosimum sp. (Moraceae).

Resin, gum or sap exudates are difficult to distinguish in the field, however, resin is a viscous substance, usually aromatic, which solidifies on contact with air and is common in the Anacardiaceae and Burseraceae family.

Gum is a substance similar to resin, however, it is odourless and soluble in water, ranging from colourless (Copaifera langsdorffii - Fabaceae) to red (Pterocarpus violaceus – Fabaceae).

Sap is a watery nutritive substance transported by the phloem vessels. It is common in the family Fabaceae and is usually reddish in Myristicaceae.

The speed and amount of exudate is also indicative of taxonomic group or species

(Figure 14).

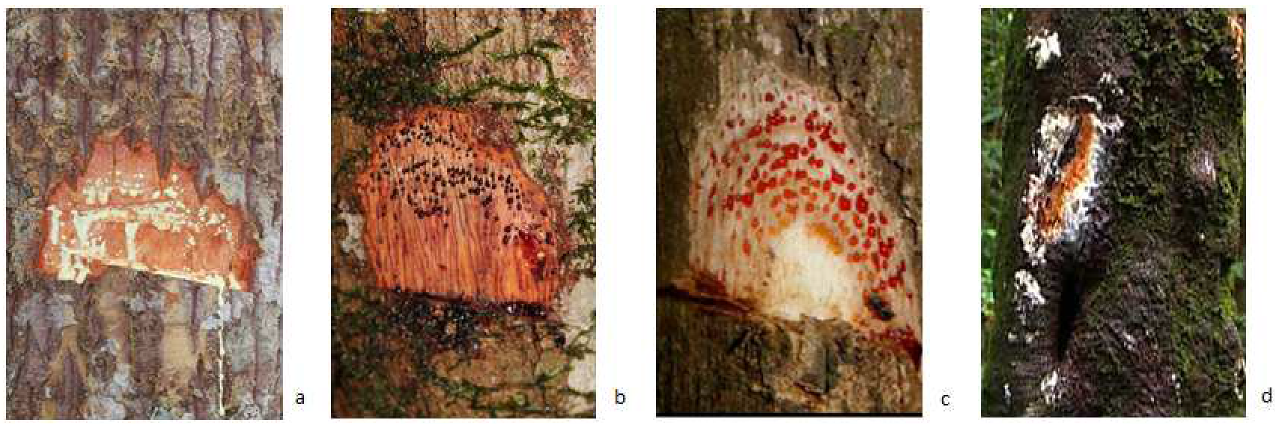


Figure 14: Types of exudates, s) latex; b) gum; c) sap; d) resin.

Many plants have odours in the inner bark or the leaves that allow for the recognition of many families. These odours are normally associated with better known plants and recognition varies from one identifier to another.

Some families such as Lauraceae, for example, have an odour characteristic of essential aromatic oil. Another family which has a very characteristic odour is Lecythidaceae, recognized by the smell of "linseed".

The colour of the inner bark, in addition to other feature such as markings, scores and fibres also complement the information obtained for the bark of trees. The colour change during oxidation of the inner bark when in contact with air is a typical feature of some families such as Lauraceae, Boraginaceae and Nyctaginaceae.

The combination of these various characters of the plants may suggest its identity however, the leaf type and phyllotaxis (leaf arrangement) are critical to identifying the family. Due to the hight of the canopy, leaf the characteristics can be observed using binoculars, or by the fallen leaves on the ground. In many cases it is necessary to collect material for a subsequent identification in a herbarium.

It is the combination of all characteristics of the stem and vegetative material that enables the families, genera and species of trees to be identified. Thus the absence of observation of some characteristic of an individual compromise identification. To avoid missing out some important information all the necessary characteristics must be monitored systematically and the information, especially of the trunk should be stored in a dendrological record.

Characteristics of the leaf can be further observed in a herbarium.

The leaves are first classified as simple or composed of subunits (compound), differentiated by the presence of a vegetative bud in the axil. The leaves are also classified by phyllotaxy or arrangement. Simple leaves can be verticillate (three or more leaves at the same point), common in the family Vochysiaceae; opposed leaves as seen, for example, in Myrtaceae, Clusiaceae, Vochysiaceae and Rubiaceae; or alternate. Simple alternate leaves can be distichous (in one plane) common in Annonaceae and Myristicaceae families; or spiraled, present in the Lauraceae family, Moraceae and Sapotaceae. The compound leaves also appear as opposed, Jacaranda sp. (Bignoniaceae) or alternating in Anacardiaceae, Fabaceae, Meliaceae, Sapindaceae and Simaroubaceae.

Plants have venation patterns classified into

- pinnate (one midrib and several secondary veins) the most common pattern among the plants;
- palmate (Have 3, 5 or 7 main ribs), present in many genres and Malvaceae Euphorbiaceae;
- curved (secondary veins start and end together), common in Melastomataceae;
- "clusia type" (secondary veins close and parallel) feature Clusiaceae and gender Microphilis sp. (Sapotaceae); and
- marginal rib (thin rib next to leaf margin), common in Myrtaceae and Vochysiaceae families.

The presence of stipules, domatia (structures which often house mutualistic ants) and glands also help in recognizing families.

Stipules are laminar formations at the base of the petiole or between petioles, common in Rubiaceae, Quiinaceae and Chrysobalanaceae.

Glands are small secreting organs which when translucent and dispersed throughout the lamina are typical of Myrtaceae and Rutaceae families; stipules present on the rachis are characteristic in most Fabaceae species, subspecies - Mimosoideae and between or among the leaflets Caesalpinoideae subspecies. Glands at the base of the leaf blade or petiole occur in Euphorbiaceae and Vochysiaceae.

Domatia are depressions or tufts of hair in the axil of the midrib, apex of petiole, base of the leaf or branch, occurring, for example, in Lauraceae and Combretaceae.

You may need to use all these features together with the material collected in order to able to identify the species in the herbarium. In many cases it is not possible to identify to the species level with non-reproductive material and it is necessary to periodically visit individuals to collect source material with flowers and fruit.

Marking of individuals

All the trees recorded in the survey should be sequentially numbered and marked with lightweight aluminium tags secured with galvanized nails. This marking is not needed to calculate the tree density or their commercial value, however, since a significant effort was made to map and identify the trees, the little extra effort to allow future studies of forest dynamics and create a living herbarium, is almost always worth it. This permanent marking will allow for monitoring of the dynamics of forest, enabling to monitor the growth, mortality and recruitment of individuals. The marking should be done sequentially along the track, 30 cm above the POM to facilitate finding the tree for later monitoring.

While this is being done, it's important that the observer does not look for other commercial species nearby in order to avoid overestimates of the density at that location. All sightings must be made from the track, so as not to affect seeing the target individuals and not modify the detection curve. Upon returning to the trail to resume the survey, the observer must not look back for species of interest with DBH ≥ 10 cm. After arriving at the next 50m picket pull the tape free and start anew, securing the tape with a new piece of wood. The procedure is repeated sequentially until the end of the trail.

It is not necessary to complete the entire trail in one day. It usually takes around 3 to 4 days to survey a 5 km trail (Albernaz, with comm.). It is very important to record any changes that occur during the survey, for example, if the observer changes, the detection rate will change.

If you want to monitor trees for carrying out growth studies, the time interval between surveys may vary, but the analysis is facilitated if all the trees are remeasured at equally spaced time intervals or the same time in the subsequent year. Measurements of the diameter should be made exactly where the tree was measured previously, but if this is not possible because of a change in the tree such as a new deformity, the new POM must registered together with information about why the change was made. It is important to remember that once the trees have been recorded, subsequent surveys are much faster, since only new recruits will now require identification.

With the collected data you can calculate the necessary parameters for your study. For individual density calculations per area the Distance program is used. It is available free at: http://www.ruwpa.st-and.ac.uk/distance/. The instructions for estimating by species are provided. Even after calculating all parameters necessary your work is not over! Do not forget to deposit data documents and metadata in a public data repository. Otherwise, all your field work may have been in vain, and future studies will be unfeasible.

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Worksheet – Metadata

Title:

Team:

Geographical Range:

Temporal Range:

Collection Method:

Data Archive (filename):

Attribute Information:

Name of Attribute	Definition
Date	Date of data collection
No.	Identification number of tree
T	Transect Id No.
Seg	Segment where the tree was located
Side	Which side of the trail was the tree located (L)eft or (R)ight
Species	Species Name
DBH	Diameter in cms
POM	Height of diameter measurement in cms
X(m)	Perpendicular distance in meters
Y(m)	Distance along the trail in meters
Obs	Relevant Observations.

Data Sheet – Commercially Viable Trees.

Location: Date:

Trail: Trail Length: Team:

No.	T/Seg	Side	Species	DBH	POM	X (m)	Y(m)	Obs