Sub-protocol 4: Tree Monitoring

Includes siting of monitoring plots and field-based tree monitoring suitable for baseline establishment and monitoring all restoration methods including natural regeneration, and subsequent calculations of survival rates. Also gives optional guidance for carbon stock assessment.

Provides field data for impact indicator A: # of trees restored (survived and crowded in) after 5 years, indicator 1.2: # of trees naturally regenerating per area under restoration, and indicator 1.5: % survival of planted trees after 5 years.

The results generated from this analysis will be compared with the remote sensing of trees data (subprotocol 1) which only works on trees of a size visible by remote sensing. Whereas this field tree monitoring is only done on one sample area per hectare, the remote sensing of trees is done taking far more samples distributed across the entire area under restoration. Information from both methodologies will be useful in informing the final # of trees restored for the Program.

Created by Starry Sprenkle-Hyppolite, Danielle Celentano, Leon Theron, Isabel Hillman and Elise Harrigan at CI, with references to monitoring protocols listed in Reference section.

Data collected by project developers and submitted to IMP. Analyses completed by the global monitoring team. Required in all projects.

Disclaimer: It is extremely challenging to achieve a generic set of monitoring requirements that can be spread across all of the possible PPC Program sites. The following is meant as guidance for the minimum set of requirements for the PPC Program. If you would like to add more rigorous monitoring in addition to what is laid out here, you are encouraged to do so by contacting the CI or WRI global monitoring team.

Guidance for Users

This subprotocol was developed to provide clarity on placing monitoring plots within restoration sites and field-based tree monitoring (including monitoring of natural regeneration) for *project developers*. Natural regeneration monitoring is not required for projects that exclusively consist of tree planting. However, we recommend that even tree planting projects monitor natural regeneration that is additional to their planted seedlings, in order to measure the total number of trees restored in their project, even if this method was not mentioned explicitly among their chosen methods in project targets.

This protocol also describes the data processing completed on the resulting data by the global monitoring team.

The data collected in the monitoring plots, following this procedure, will be used to extrapolate the data for the entire restored area, based on the fraction of the site that was directly measured in the monitoring plots. Because of this, it is extremely important that the monitoring plots capture representative, average areas of the restored area (potentially with a need for stratification, if there are major differences). It is also essential that there are an adequate number of monitoring plots. Guidance for this is given in the following sections.

This protocol includes both the minimal required monitoring to satisfy the PPC Program requirements, as well as additional optional guidelines for more intensive monitoring for projects seeking to estimate the carbon sequestered. Please note that the additional tree monitoring suggested here, by itself, will not be enough to allow for carbon crediting, and, carbon crediting is not possible in all of the areas that the PPC works. There are many more steps to this process, including submitting more detailed Project Design Documents, baseline analyses, and analysis of additionality and leakage. Full guidelines for this are still in development (expected by end of 2022).

Field-based monitoring of trees is designed to inform and connect to remotely sensed monitoring, covered in subprotocol 1.

Timing & Frequency of monitoring:

Monitoring of restored areas should consist of a baseline (to document existing trees prior or at the time of planting), Year 2.5 and Year 5, but if time and resources allow, it could be monitored every year. This monitoring doesn't replace site management that may need to occur more frequently.

Importance of Tree Monitoring

Monitoring of trees allows us to calculate overall diversity and species richness of planted and regenerating trees (regenerants) in restoration sites. This monitoring will help to inform potential adaptive management, especially in situations where the planted tree species have low survival rates and learning about more appropriate species is needed. Any learnings should be carried over into species selection for future enrichment plantings.

METHODOLOGY

We assume that the site, or 'restored area,' is already defined by a GIS shapefile and the basic site information has been submitted in the establishment report.

The following procedures must be followed to ensure proper data collection.

> **Definition of Restored Areas by Restoration Methodology**: In general, an area defined as a 'restored area' will have a single restoration method (or a designated combination of methods) applied ***consistently*** across the ***entire site***. If this is not the case, and different restoration methods are used in different parts of a restored area, separate polygons within a shapefile are created for the areas with the different methods (or combination of methods). The easiest example to illustrate this is if the site is divided in half, with one method on one side and another on the other, as in an experimental design to test different methods (See Figure 1). Each of these areas would need to be treated separately for monitoring: the monitoring protocol described below would apply to each of those sub-divided restored areas, separately.

Stratification: If the restored area has significant diversity of topography, vegetation, land use history, disturbance etc., that may significantly impact the restoration success, the implementors should stratify the monitoring plots to represent and capture these differences (Figure 1). For example, if half of the site has a very strong slope and half is flat, plots should be randomized within the sloping half and the flat half. This may be especially important if there are multiple vegetation types (i.e. bare ground vs.

grass vs. secondary growth) in the area. Implementors need to define the different zones and ensure that monitoring plots are placed in those zones. This stratification, or zoning, should be noted in the monitoring plot information. This is especially important if the developer is planning to make carbon estimations for the restored area.

Stratification in context of carbon standard compliance: Grouping similar vegetation types together based on biomass, species composition, soil type and structure helps to reduce the overall variance and reduces uncertainty. Satellite imagery is most often used in the first iteration of stratification and it can then be further refined combined with topographic maps and initial field sampling.

The planned restoration area can be first classified using the most recently available and highest resolution satellite imagery available and the area can be classified based on canopy cover, although canopy cover classification can be difficult for sparse, degraded forests. Adjustments can be made following a trial field survey.

It must be noted though that stratification is not essential for carbon verification, but it does bring down uncertainty and prevents confidence deductions. Verifiers will not scrutinize the actual stratification in great detail unless a specific project has reason to distinguish carefully between land cover classes. Verifiers will focus on the uncertainty (variation) levels of each stratum.

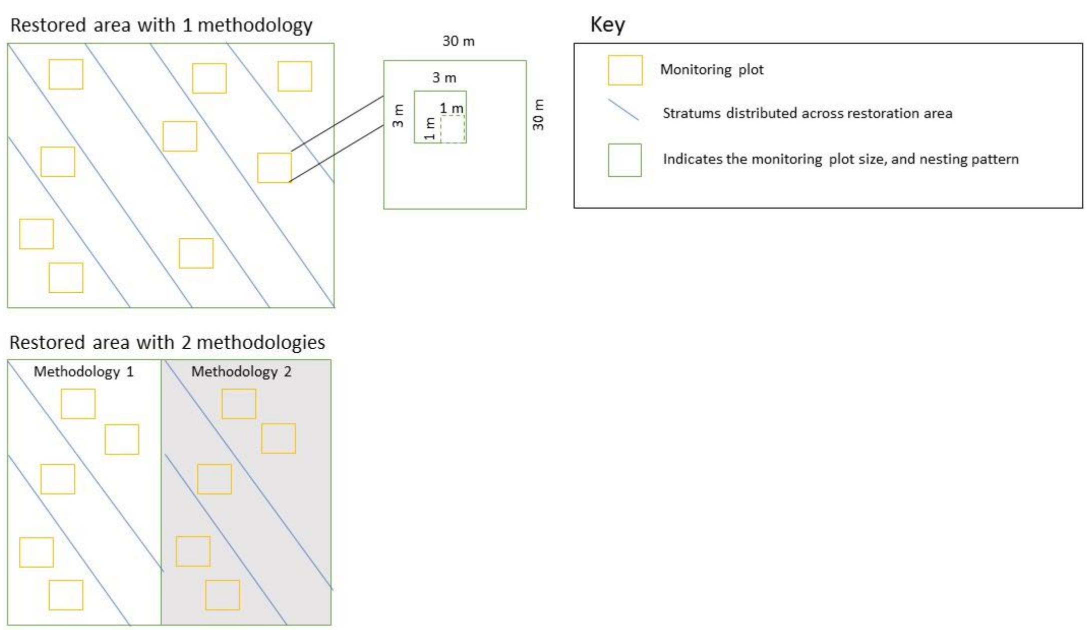


Figure 1. Restored areas using 1 (above) or 2 restoration methodologies

<u>Determining the number of monitoring plots according to the size of the restored area in hectares for restored areas (sites)</u>

In order to ensure adequate sampling for data extrapolation, it is extremely important that there are an adequate number of monitoring plots. The number of monitoring plots required is based on the size of the restored area, and varies whether or not the developer is pursuing field-based carbon estimation (optional). We propose a simple area-based method for determining the number of monitoring plots, which also sets the required minimum, in Table 1. Implementors who would like to use a more technical method for determining the correct sampling ratio, for example utilizing their own knowledge of expected variance to conduct a power analysis, are welcome to do so. If a more technical method is utilized, the global monitoring team must review and approve it. The number of monitoring plots cannot be less than the required minimum (Table 1) unless the method is approved and the number of plots agreed with the global monitoring team.

Table 1: The minimum number of monitoring plots based on the size of the restored area (in hectares).

Restored Area (ha) = A	Number of Plots (minimum PPC standard)
A ≤ 50	1 per hectare
A > 50 ≤ 100	1 per ha for 1st 50, 1 per 2ha for 2nd 50
A > 100	1 per ha for 1st 50, 1 per 2ha for 2nd 50, 1 per 5ha for all over 100

<u>Determining the number of plots per stratum for carbon projects.</u>

For carbon verification, the density of sampling is determined by the level of uncertainty[1] desired. If the uncertainty exceeds 10%, confidence deductions will have to be applied to carbon values: the baseline must be adjusted upwards and the project carbon stock downwards (see ar-am-tool-14-v4.2.pdf (unfccc.int)).

The following Clean Development Method (CDM) A/R Tool describes how to calculate the number of plots per stratum: CDM AR (unfccc.int)

Winrock has a spreadsheet tool that can be used to calculate the number of plots per stratum Winrock_Sample_Plot_Calculator_Spreadsheet_Tool and it can also be used to get cost estimates of sampling.

<u>Determining the location of monitoring plots within the restored area</u>

Location and orientation:

Each corner of the monitoring plot should be recorded using a GPS device.

Distribution of plots:

The sampling plots should be evenly distributed across the site, (I.e. they cannot be clumped in one or two ends/edges of the site). You could imagine a one-square hectare grid spreads across the site, and one plot should be placed in each square hectare (for example, for sites up to 50 ha in size).

[1] Uncertainty is in the mean value of an estimated parameter equal to the estimated standard error of the mean expanded to 90% confidence level divided by the mean value, expressed as a percentage

The location of the monitoring plots should be random, within the square-hectare grid. All plots should be oriented so their edges run along north-south and east-west axes.

To determine where plots should be placed the center points of the plots, referred to as “plot centroids,” can be generated in ArcGIS using the Fishnet tool at 30-meter spacing, and telling the program to randomly choose the locations of the centroids. Alternatively, you can use a random number generator like a stopwatch to determine the number of steps or meters away from the edges of the site a plot should be placed.

Some corrections may be needed to the randomized placement. For example, the distribution of plots should also account for any strata present across the site. For example, if your site has no vegetation on 30% of its area, and some secondary growth on 70%, those are two different vegetative strata. You might need to break the rule of random placement for some of the plots to ensure that the right fraction are in each stratum.

Your monitoring plots should have the same distribution within the strata- 30% of your tree monitoring plots should fall in the no vegetation area, or stratum, while the other 70% fall within the secondary growth area, or stratum. If you have multiple strata in a small restored area, and the number of vegetative strata exceeds the number of hectares being restored, you will need to exceed the 1/ha minimum monitoring requirement, to ensure some monitoring coverage in each strata (i.e. 2 plots would be needed in a 1 ha plot w/2 vegetative strata).

Finally, plots should also not be placed within 5 meters of the restoration site’s boundary, to avoid edge effects.

Monitoring Plot Description:

All monitoring plots are 30 m x 30 m, where all large tree species (> 10 cm Diameter at Breast Height – DBH) are recorded. Within each stratum, for each hectare of restored area, the 30m x 30m plot will contain 1 or 2 smaller nested plots, one that is 3 m x 3m (9 m^2) and, inside of that one, one optional plot that is 1m x 1m (1 m^2), for the monitoring of smaller trees, as described in the section below (illustrated in Figure 2). The location of the sub-plots consisting of the 3m x 3m and 1m x 1m plot are randomized within the permanent 30m x 30m plot the first time, but thereafter should remain permanent.

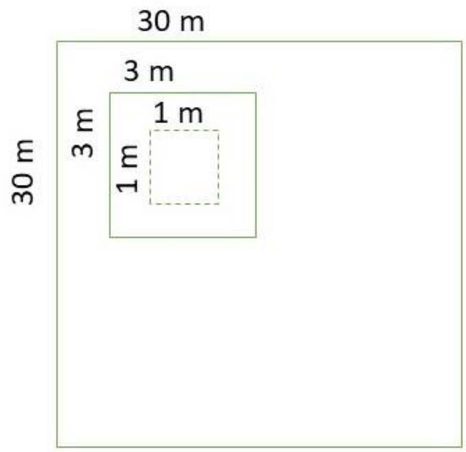


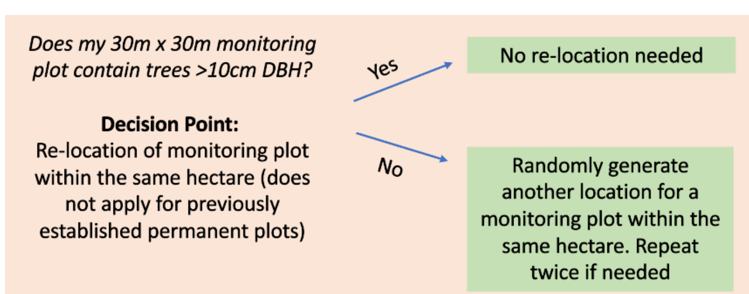
Figure 2: Nested Monitoring Plot arrangements of large 30m x 30m (900 m^2), medium 3m x 3m ($9m^2$), and optional small 1m x 1m ($1m^2$).

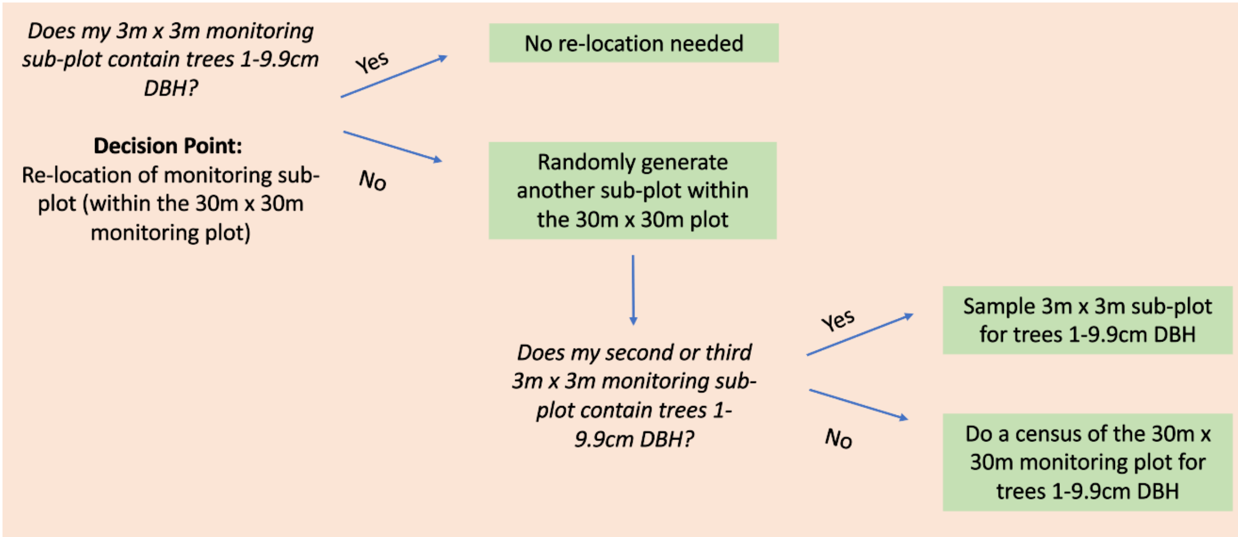
Modifications for Empty Plots:

If there are no trees > 10 cm DBH found in the initial 30 x 30 m plot, then that plot should be counted as 'empty' and a new plot selected in a new random location within the same 1 ha sampling area. This may be done twice. If 2 additional empty plots are found, then, the 3rd plot should be monitored, even if it is empty. The fact that there were 2 empty plots registered prior to the placement of the plot should be noted, as it will be factored into the extrapolation of the data.

If this 3rd plot is also devoid of any trees > 10 cm DBH, this can be noted in the data sheet. The nested 3 x 3 plot should then be checked for trees 1-9.9cm. If there are none, then, the nested plot should also be counted as empty and a new plot selected in a new random location within the 30x30 m plot. Again, this may be done twice. If 2 additional empty plots are found, then, a full census count of the 1-9.9 cm size class should be done in the entire 30x30 m plot.

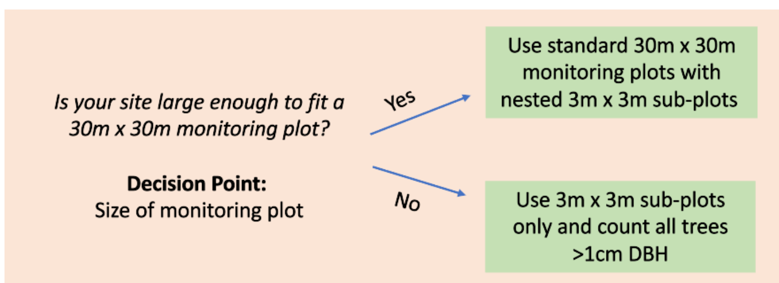
If, on the contrary, there are trees > 10 cm DBH found in the initial 30 x 30 m plot, but then, there are no trees 1-9.9 cm within the 30x30 m plot, the same procedure as above applied: the nested plot should also be counted as empty and a new plot selected in a new random location within the 30x30 m plot. Again, if 2 additional empty plots are found, then, a full census count of the 1-9.9 cm size class should be done in the entire 30x30 m plot.





Modification for Sites Smaller than 30m Wide

If an entire restoration site is smaller than 30m wide, and therefore a 30m x 30m tree monitoring plot will not fit on the site, then this constraint should be denoted in the data sheet, and a 3m x 3m sub-plot should still be used. In this scenario, all trees >1cm DBH within the 3m x 3m plot should be recorded in the data sheet. The number of 3m x 3m plots should match the number of plots outlined in Table 1.



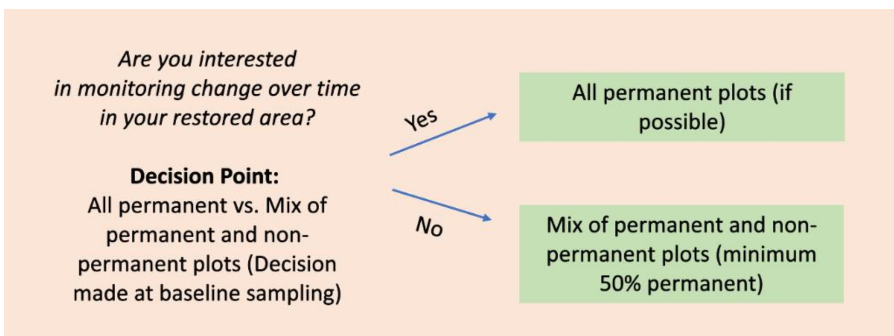
Permanent & Non-Permanent Plots

Permanent monitoring plots, where the same exact location is monitored every time data is collected, are recommended if the focus is scientific research or when the funding comes from banks or official agencies (PACTO, 2013) or if the project will seek accreditation with one of the carbon standards. A combination of permanent plots and non-permanent plots (where the location is randomized each time) is also acceptable – **but a minimum of 50% permanent plots should be maintained** (PACTO, 2013).

The locations of the large (30x30m) monitoring plots will be randomly selected within the project area for baseline data collection. Subsequently, if some non-permanent plots are desired, then half of the large plots should still remain as permanent plots, and the other 1/2 will be re-randomized at each data collection (Y2.5 and Y5 or more frequently if more monitoring is done). If there is only one plot, or an uneven number of plots, then the plot should be permanent.

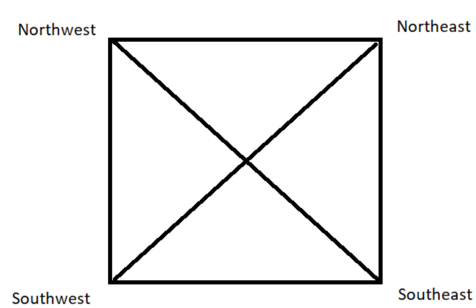
Each permanent plot must be georeferenced with landmarks in the ground (wood staking, iron pipes, rebar, or PvE tubing) at 1.2 m in height (PACTO, 2013) and GPS corner points and centroids recorded along with device margin of error. The GPS corner points and centroids of non-permanent plots will also be recorded at the time of monitoring, but they do not need to be marked with landmarks. Each plot should also be denoted as permanent or non-permanent in data collection to avoid accidental re-randomization of permanent plots. If the plot is nested and permanent, the corners of the nested (3m x 3m and 1m x 1m) plots should also be georeferenced with landmarks, but only the centroid is recorded using the GPS. All nested plots (3m x 3m and 1m x 1m) should also have descriptions of their locations within the larger (30m x 30m) plot. In areas with a lot of human activity where there is a risk that visible markers might be taken, plots can be monumented (permanently demarcated) by driving a metal stake into the ground which can be found again with a metal detector.

The number of trees that have been planted into each 30x30 **permanent** monitoring plot as part of the restoration intervention (regardless of their DBH, and disaggregated by species) should be recorded in the baseline information. The locations of the planted trees in permanent monitoring plots should be documented with extra care (possibly with a drawing of their locations within the plot, or at least noting their spacing and planting pattern), to enable follow-up tree monitoring and survival rate calculations.



<u>Data collection and tools:</u>

Photo: Four geotagged photos should also be taken (1 from one each corner of the 30x30 m plot), facing into the plot and zoomed out to show as much of the plot as possible.



In each monitoring sampling plot, ***counts of the trees/saplings per tree species*** must be recorded for different size classes following the instructions below. The tree diameter (DBH) and height can also be recorded, but is optional, if the developer wants to make field-based carbon estimations.

In the 30 m x 30 m plots all large trees (> 10cm DBH) per tree species are counted. DBH and height can be optionally recorded for each individual tree. In the nested 3 m x 3m (9 m^2) all medium sized trees/saplings (diameters 1 – 9.9 cm DBH) per tree species are recorded. DBH and height can also be recorded for each individual tree, but are optional.

The smallest nested plot is completely optional. The 1x1 plot gives an indication of the emerging, very young trees on the site, and may be useful for projecting future tree density, but, individuals of the smallest size class (<1 cm DBH) will not be included in the tree count or carbon estimations. In the smallest nested plot, 1m x 1m (1 m^2) all tree saplings (<1 cm DBH) will be counted and identified to species or species type as much as is possible (no height or DBH measurements for this small category, adapted from Celentano et al., 2020) Data should be recorded following the template of Form 1 in Annex 1, which will be done using the integrated monitoring platform data collection app.

When this protocol is followed in the baseline period, the presence of existing trees in the restoration sites (inside the monitoring plots) is important to note. These trees will not be counted as trees restored by the project, because they were already present. The number of trees in the sampling plot will be extrapolated across the total restored area. Hence, if there are parts of the plot with more trees already present in the baseline period, it is important to follow a good stratification procedure based on the vegetation type (I.e., with trees vs. without trees), to generate an accurate extrapolation across the restored area.

Measuring protocols:

- (Optional) Diameter at Breast Height (DBH): Use a forestry-grade DBH measuring tape at diameter at breast height (1.3 m) around the stem or trunk of the tree. Record in metric units.
  - If stems have bifurcated below 1.3m, DBH should be taken from all stems above 1.3m (PACTO, 2013)
- (Optional) Height: Use a clinometer, or for Saplings or regenerants too small for the use of a clinometer, use measuring stick. Note that for carbon accreditation, height is sometimes an optional recording, it depends on the allometric model used.
- Species must also be recorded for carbon accreditation, again to apply the correct species specific allometric models (there are many generic ones to).

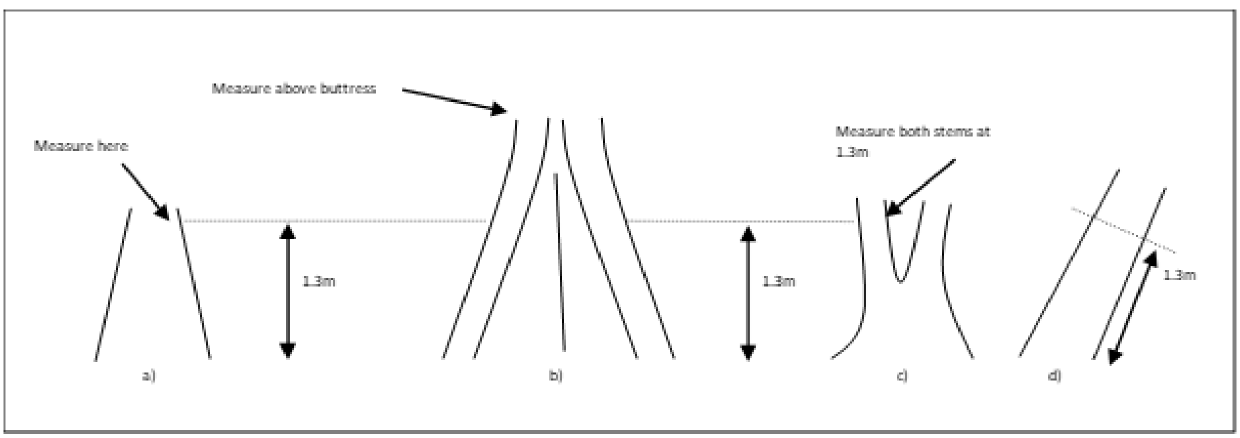


Figure 5. Measuring position for various different trunks, **a**) single, straight trunk, **b**) trunk with buttresses, measured above buttresses and **c**) trunk that forks before 1.3m and **d**) a leaning tree.

How to Distinguish a Naturally Regenerating Tree from a Planted/Seeded Tree

In plots where direct planting and natural regeneration both occur, it may be challenging to distinguish the planted trees from the naturally regenerating trees. The developer may have chosen to tag the planted trees or mark their positions, for example with a stake, but such markings may become lost, damaged, or even stolen during the full duration of the monitoring.

The historical knowledge of the planting patterns used (I.e. if it was a grid, what was the spacing of the grid, and/or what was the orientation (N/S/E/W) and spacing of the rows) will be essential to help in this task of distinguishing between a planted/seeded tree and a naturally regenerating tree.

In general, a tree is probably a regenerant (i.e., not planted) when any of the three following conditions apply:

1) it is located outside a known planting row or grid position

2) it is an obviously different size (either bigger or smaller suggesting more than one year's difference in age) than the observed range of sizes of the planted/seeded trees or

3) it is not included in the species list of planted/seeded trees (PACTO, 2013)

While it can be difficult to distinguish between planted and naturally regenerated trees, a localized mechanism to judge which trees are planted and which are naturally regenerating helps to count the total number of trees restored (Impact Indicator A). If a different method for distinguishing trees is used in your plots, it should be shared for discussion at PPCMonitoring@conservation.org

Determining When a Tree is 'Regenerated'

Naturally regenerating saplings must attain a verifiable age of over 1 year, or an equivalent, regionally specified size threshold, to be counted as 'restored' in reporting to the PPC. An absolute minimum threshold size should be 1 cm DBH, I.e., trees that would meet the requirement for monitoring in the "medium" 3 x 3 m nested plot. The individual counts of smaller regenerating trees from the 1x1m nested plots are indicative of the seed bank and biodiversity, but trees in that size class will not be counted as "restored" or "regenerated" in Y5. We note that the field monitoring procedure will likely allow for better detection of the "medium" size class of saplings, which may not be detectable by remote sensing.

Reporting:

Data sheets are provided in the annex for your use to collect, record and track over the project's duration. Data should be reported for each monitoring plot.

Data Processing (to be done by the global monitoring team from the plot monitoring data submitted):

In order to extrapolate Impact Indicator A: # of trees restored (survived and crowded in) after 5 years, Indicator 1.2: # of trees naturally regenerating per area under restoration and Indicator 1.5: % survival of planted trees, the data from the Y5 monitoring will be compared to the baseline data.

To get A: # of trees restored (survived and crowded in) after 5 years & Indicator 1.2: # of trees naturally regenerating per area under restoration – both potentially disaggregated by species and by origin (pre-existing, planted, naturally regenerated) requires multiple steps for each disaggregated group:

1. Calculating sampling ratios per stratum:

The area monitored in each stratum (including the number of 'empty' plots if applicable) will be divided by the total area of the restored area in that stratum, to get the sampling ratio for the stratum. If no strata were defined, then, the total area monitored can be divided by the total restored area to get the sampling ratio. See table 1 for minimum sampling ratio.

2. Extrapolations within each monitoring plot:

If the regular nested protocol was followed, the number of medium trees with DBH > 1 cm observed in the 3x3 (9 m2) plot will be extrapolated to the 30m2 plot by multiplying by (30/9). This number will be added to the total number of large trees with DBH > 10 cm that were directly observed in the 30 m2 plot, to get the total extrapolation of trees for the monitoring plot.

If there were 1-2 'empty' plots, but then a successful 3x3 plot, then the multiplication factor will decrease (30/18 for 1 empty plot, 30/27 for 2). If there were 3 empty plots, resulting in a census of the 30x30 plot, then the censused number can be used directly as the number of trees in the monitoring plot.

Because we will be later subtracting the number of trees counted in the baseline, all trees except the trees that are known to have been planted should be included in these calculations (i.e., including trees that were potentially already on site at the baseline).

1. *Extrapolations to restored area:*

The extrapolations of total trees for each monitoring plot will be summed within each stratum and multiplied by 1/sampling ratio, to extrapolate the total trees for the stratum. If no strata were defined, then, the extrapolations of total trees for each monitoring plot can be summed and multiplied by 1/sampling ratio.

1. Finally, the extrapolation of total trees present during the baseline monitoring should be subtracted from the total extrapolation of naturally regenerated trees present in the monitoring period (not including trees planted), to get the number of trees naturally regenerated (indicator 1.2).

Calculating Survival Rate:

Survival rate at Y5 will be calculated using this simple equation:

Within Plot Survival Rate = (# of living planted trees in 30 x 30 m plot at Y5** / # of planted trees in 30 x 30 m plot at Y_0) * 100

***may be done either with a full census of the 30 x 30 m plot for planted trees at Y5 or by extrapolating the number of living planted trees from the number found in the 3x3 m plot, proportionately*

Survival rates within each monitoring plot will be averaged to produce the overall survival rate for the site.

Additional data that can be generated per site with this data:

(if recorded): Average size (DBH and/or height) of trees, disaggregated by species

Calculating carbon content:

There are many ways to calculate ex-ante carbon stocks. In forestry projects Mean Annual Increment data and Biomass Expansion Factors are typically used, sourcing the data from local growth charts or simply using IPCC defaults. For natural regeneration projects data on regrowth can be sourced from suitable literature.

For post ex calculations, the first step is to select an appropriate allometric equation. Globallometree is a global source of equations http://www.globallometree.org/

It is important to make sure that allometric equations used are conservative if they are not site specific and peer reviewed. Generic non-specific equations often work well in certain forest types. Make sure that whichever equation is chosen that it is applied within it's limits, e.g. if a specific equation was developed for DBH between 5 and 55cm it cannot be ablied to trees with a DBH over 55 or below 5 cm.

The following CDM methodology can be used to calculate carbon stocks ar-am-tool-14-v4.2.pdf (unfccc.int).

Please note that even if all of the above procedures are followed, this procedure alone will not make a project eligible to issue carbon credits. There are other important steps related to project design and verification, following authorized carbon standards, that are required to do so.

Resources:

Celentano, D., Rousseau, G. X., Paixão, L. S., Lourenço, F., Cardozo, E. G., Rodrigues, T. O., E Silva, H. R., Medina, J., de Sousa, T. M. C., Rocha, A. E., & de Oliveira Reis, F. (2020). Carbon sequestration and nutrient cycling in agroforestry systems on degraded soils of Eastern Amazon, Brazil. Agroforestry Systems, 94(5), 1781–1792. https://doi.org/10.1007/s10457-020-00496-4

Chazdon, R. L., & Guariguata, M. R. (2016). Natural regeneration as a tool for large-scale forest restoration in the tropics: prospects and challenges. Biotropica, 48(6), 716–730. https://doi.org/10.1111/btp.12381

Chazdon, R. L. (2013). Making Tropical Succession and Landscape Reforestation Successful. Journal of Sustainable Forestry, 32(7), 649–658. https://doi.org/10.1080/10549811.2013.817340

FAO. 2019. Restoring forest landscapes through assisted natural regeneration (ANR) – A practical manual. Bangkok. 52 pp. Licence: CC BY-NC-SA 3.0 IGO.

PACTO. (2013). PACTO Pela Restauração da Mata Atlântica. Atlantic Forest Restoration Pact. https://www.pactomataatlantica.org.br

Annex 1. Data Collection Form Description
Table detailing the information collected during tree monitoring. Items highlighted in grey are optional. Data is collected using KoboToolbox, which can be accessed on the IMP.

Data Collected	Options	Data Type	Notes
General Information			

Date		Date	
Organization Name		Select one from list	
Site ID		Select one from list	
Sampling Timeframe	Y0 (baseline), Y2.5, Y5, Other	Select one from list	
Site Type	Control, Restoration	Select one from list	
Start time of data collection		Time	
End time of data collection		Time	
Plot Information			
Plot ID		Text	
Plot Type	Control, restoration	Select one from list	All restoration should be looking for natural regen
Plot permanence	Permanent, Randomized	Select one from list	
Strata		Text	NA if only 1 stratum, if multiple in restored area then match answer with strata identified in site establishment form
Number of resamplings needed for 30m x 30m monitoring plot	0, 1, 2	Select one from list	A resampling (relocation of the plot within the same hectare) occurs if there are no trees >10cm DBH in the plot. Does not apply to permanent plots except at baseline
Description of tree planting pattern within monitoring plot (if planting has already occurred)		Text	Grid spacing, clumping, etc
Coordinate System Used		Text	
Northeast corner of plot (30x30)		GPS coordinate	
Device margin of error (NE corner)			Automatically included in KoboToolbox
Northwest corner of plot (30x30)		GPS coordinate	
Device margin of error (NW corner)			Automatically included in KoboToolbox

Southeast corner of plot (30x30)		GPS coordinate	
Device margin of error (SE corner)			Automatically included in KoboToolbox
Southwest corner of plot (30x30)		GPS coordinate	
Device margin of error (SW corner)			Automatically included in KoboToolbox
Trees in 30m X 30m Plot All trees > 10cm DBH by species and type should be recorded. Separately, any PLANTED trees that have not yet reached 10cm DBH should also be recorded. ** Note that DBH and height measurements are not required, only a count by size class, disaggregated by species and type*			
Count of trees (>10 cm DBH)	Disaggregated by species and type (naturally regenerating, planted by your project, already present prior to project, don't know)	Integer + species + select one from list (type)	If using this sheet for data collection, repeat this line for each species and type. Ex: species A, count of 2, and naturally regenerating Species A, count of 3, planted by your project
Count of PLANTED trees (only trees that are smaller than 10cm DBH)	Disaggregated by species	Integer + species	If using this sheet for data collection, repeat the line for each species. Ex: species A, count of 2
Notes		Text	
4 geotagged photos		Picture upload	Photos should be taken from each corner of the plot facing into the plot and zoomed out to cover as much of the plot as possible
Trees in 3m X 3m Plots In the nested 3m x 3m sub-plots all trees with a diameter between 1 – 9.9 cm DBH are recorded ** Note that DBH and height measurements are not required, only a count by size class, disaggregated by species and type*			
Number of resamplings needed for 3m x 3m sub-plot	0, 1, 2	Select one from list	A resampling (relocation of the sub-plot within the 30m x 30m plot) occurs if there are no trees 1 - 9.9 cm DBH in the sub-plot
Count of trees (1-9.9 cm DBH)	Disaggregated by species and type (naturally regenerating, planted by your project, already present prior to project, don't know)	Integer + species + select one from list (type)	If using this sheet for data collection, repeat this line for each species and type. Ex: species A, count of 2, and naturally regenerating

			Species A, count of 3, planted by your project
Notes		Text	
Centroid		GPS coordinate	
Description of location within 30m x 30m plot		Text	
(Optional) Additional Photos			
Saplings in 1m X 1m Plots In the smallest nested plot, 1m x 1m (1 m2) all saplings (regenerants) (<1 cm DBH) will be recorded. At this size, it is important to distinguish between trees and shrubs			
(Optional) Count of saplings (<1cm DBH)	Disaggregate by species and types (naturally regenerating, planted, don't know)	Integer + species + select one from list (type)	
(Optional) Centroid		GPS coordinate	
(Optional) Description of location within 3m x 3m plot		Text	
Additional Information			
(Optional) File Upload		File upload	

Special Circumstance: Restoration Site is too small to fit 30m x 30m plot In this scenario, a 3m x 3m sub-plot is sampled. A count of trees >1cm DBH is conducted			
Count of trees (>1cm DBH)	Disaggregated by species and type (naturally regenerating, planted by your project, already present prior to project, don't know)	Integer + species + select one from list (type)	If using this sheet for data collection, repeat this line for each species and type. Ex: species A, count of 2, and naturally regenerating Species A, count of 3, planted by your project
Notes		Text	
Centroid		GPS Coordinate	
Description of location within 30m x 30m plot		Text	

(Optional) Additional Photos			

Special Circumstance: Sub-plot is resampled 3 times, and still contains no trees from 1-9.9 cm DBH In this scenario, a census of the 30m x 30m plot is done for trees from 1-9.9 cm DBH in addition to trees >10cm DBH. Separately, any PLANTED trees within the plot that aren't >1cm DBH should also be recorded			
Count of trees (1-9.9 cm DBH)	Disaggregated by species and type (naturally regenerating, planted by your project, already present prior to project, don't know)	Integer + species + select one from list (type)	
Notes		Text	
(Optional) Additional Photos			