Version 1.5 | September 14, 2017

Project Monitoring and Carbon Stock Quantification Guidance

Mexico Forest Protocol

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1 Introduction

This section addresses quantification requirements to determine the project's baseline, to determine project inventories for crediting, and to ensure project compliance with environmental safeguards and leakage requirements in ongoing monitoring activities.

Specific goals of quantification activities are:

1. To develop a risk profile to the project's forest cover for baseline purposes.[1]
2. Provide accurate estimates of carbon stocks within project Activity Areas for purposes of reporting carbon stocks for crediting.
3. Ensure that credited stocks meet permanence requirements and environmental safeguards related to native species and harvest retention.
4. Ensure that forest cover is sustained in Non-Activity Areas within Project Area to address internal leakage (leakage within the entity's landholdings).

The quantification guidance is standardized to increase efficiency, provide consistency between projects and establish an objective and clear basis for project verification. The approach to quantification and monitoring of onsite carbon stocks is designed to be inclusive of a broad range of project activities. Activities such as agroforestry, sustainable forest management, and reforestation can be quantified under one project with a goal of improving project quantification and monitoring efficiencies.

All projects must download a database and application from the Reserve's website that facilitates inventory calculations and monitoring. The database and application is called 'CALCBOSK' and is referred to throughout this section.

[1] The sampling methodology for forest canopy estimates used for determining the project's baseline is also used for ongoing monitoring activities for the Project Area.

2 Project Area Sampling: Baseline Development and Project Area Monitoring

For eligible projects, the baseline is calculated as the sum of carbon inventories in the required pools (tCO_2e) for each Activity Area. Projects that do not meet the minimum threshold for risk are not eligible under this protocol. Both the baseline development and project monitoring are based on the development of estimates of area in varying land cover classes and forest canopy cover area.

Forest Owners have the flexibility to postpone their baseline development until their first verification by back-casting an inventory developed within 2 years of the project Start Date. This gives the Forest Owners the flexibility to complete their initial inventory within the first two Reporting Periods (i.e. by the end of the second Reporting Period). The Forest Owner then develops an inventory that is representative of the project's Start Date by back-casting the later developed inventory.

Plot data recorded for the development of the initial inventory may include radial increment data (in the absence of other growth data), which can be used to estimate DBH and tree height at an earlier time. CALCBOSK, the companion data management tool for the Mexico Forest Protocol, will automatically back-cast inventory data to the project Start Date that is collected on a 1-year increment within the first two Reporting Periods.

The analysis is conducted using randomly placed points on remotely sensed data. This section includes a methodological approach that uses public data and a publicly available tool for establishing random points. The analysis of the point data enables the estimation of land areas converted from natural land cover to other uses and the estimation of current canopy cover, both in recently naturally disturbed areas as well as areas that have not been disturbed recently. An application on CALCBOSK is used to facilitate data management and analysis.

Randomized points are placed on the Project Area using the United States Forest Service's i-Tree Canopy Tool.[2] The Reserve will accept, and may approve, proposals of alternative methods of installing random points and/or measuring land cover and canopy cover. The Project Area is input as the area of interest in the i-Tree Canopy Tool. The Project Area can be drawn (digitized) within the i-Tree Canopy Tool or a GIS shapefile representing the Project Area can be imported. The i-Tree Canopy Tool will create random points on an aerial photo of the Project Area. The data generated from analysis are input into CALCBOSK as described in Table 2.1. In order to determine the current land cover and whether it is natural, publicly available photo images (Google Earth, etc.) from current and past years and other verifiable sources, such as local knowledge of management history, may be used to further inform the decision of land cover type; however, the most recent photo image must also be used to analyze current land cover. The reference area for determining the land cover type is an approximate 1/10th of a hectare surrounding the point; the land cover type should be identified by a pattern in land cover within the reference area. It is advisable to use the Google Earth tool to draw a polygon around the point to determine the reference area. As the determination of the reference area and land cover will require a level of subjectivity, the determination will need to be verified; however, the Reserve's default will be to assume that the Forest Owner properly determined the reference area and land cover type and the verifier should only flag cases in which there are clear and

[2] http://www.itreetools.org/canopy/.

certain errors by the Forest Owner. When determining whether the point intersects with the tree canopy, however, the defined random point is the limit of consideration.

Table 2.1. Project Area Monitoring Data Inputs

Attribute	Description
Latitude	Enter the latitude reference for the point.
Longitude	Enter the longitude reference for the point.
Current Land Cover	The current land cover type represented under the point. See the section below on Guidance for the Selection of the Vegetation/Land-Use Key.
Intersection with Tree Canopy	Does the tree intersect with a tree crown? (Tree/Non-tree)

2.1 Guidance for the Selection of the Vegetation/Land-Use Key

Selection of the vegetation/land-use key is based on the criteria provided in Table 2.2. The 'Key' Field is input into the CALCBOSK, which must be used for each project.

Table 2.2. Criteria for Selection of Landcover Key

Ecosystem	Formation	Vegetation Type	Land-Cover Key
Bosque Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ.	*Galería*	*Bosque de Galería*	CO
	Coníferas	*Bosque de ayarin* (*Ayarin* > 66% BA)	
		Bosque de cedro (*Cedro* > 66% BA)	
		Bosque de oyamel (*Oyamel* > 66% BA)	
		Bosque de pino (*Pino* > 80%)	
		Bosque de pino-encino (*Pino* > 50%, *Encino Importante*)	
		Bosque de táscate	
		Matorral de coníferas	
	Latifoliadas	*Bosque de Encino* (*Encino* > 80%)	LA
		Bosque de encino-pino (*Encino* > 50%, *Pino Importante*)	
	Mesófilo	*Mesófilo de montana*	ME
		Popal	
		Selva de galería	
		Tular	
		Vegetación de galería	
		Vegetación halófila	
Selvas Non-acahuel Tropical forest vegetation where woody perennial species are dominant that develop spontaneously, with crown cover greater than 10%.	*Selva Caducifolia*	*Matorral subtropical*	SE
		Selva baja caducifolia	
		Selva mediana caducifolia	
	Selva Espinosa	*Selva baja espinosa*	
	Selva Perennifolia	*Selva alta perennifolia*	
		Selva alta subperennifolia	
		Selva baja perennifolia	
		Selva baja subperennifolia	
		Selva mediana perennifolia	
		Selva mediana subperennifolia	
	Selva Subcaducifolia	*Selva baja subcaducifolia*	
		Selva mediana subcaducifolia	

Ecosystem	Formation	Vegetation Type	Land-Cover Key
Selva Acahuel Young tropical forest vegetation where woody perennial species are dominant that develop spontaneously, with crown cover greater than 10%.	*Same as above but regeneration (young – less than 25 years)*		SEA
Zonas áridas Vegetation that develops spontaneously in regions of arid or semiarid climate, with area larger 3 hectares.	*Matorral Xerófilo*	*Chaparral*	MA
		Matorral crasicaule	
		Matorral desértico microfilo	
		Matorral desértico rosetofilo	
		Matorral espinoso tamaulipeco	
		Matorral rosetofilo costero	
		Matorral sarcocaule	
		Matorral sarco-crasicaule	
		Matorral sarco-crasicaule de neblina	
		Matorral submontano	
		Mezquital	
		Mezquital Xerófilo	
		Vegetación de desiertos arenosos	
		Vegetación gipsofila	
Plantación Land spanning more than 3 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. Plantations are characterized by 80% cover or more of one species, little variation in age and usually young trees.	*Plantaciones Forestales*	*Bosque inducido* *Palmar inducido*	PL
Otros Usos Lands devoted principally to agriculture or buildings, water systems (including flood plains), etc. Lands can be managed with agroforestry or urban forests.	*Otros Usos*	*Agricultura*	AG
		Agroforestal	AGF
		Asentamientos Humanos	AS
		Cuerpo de agua No-Natural	AQH
		Cuerpo de agua Natural	AQ
		Zona urbana	UR
		Pastizales Naturales	PI
		Paztizales No-Naturales	PIH
		Vegetación de dunas costeras	VU
		Rocas	RO
		Chaparral	CH
		Otros Usos Humanos	UH

Ecosystem	Formation	Vegetation Type	Land-Cover Key
Vegetación Hidrófila Lands that are saturated with water to create distinct and unique plant relationships.	*Vegetación Hidrófila*	*Manglar*	VM
		Popal	VA
		Selva de galería	SG
		Tular	VT
		Vegetación de galería	VG
		Vegetación halófila	VH

** See the MFP companion tool, List of Unique Native Habitats, to identify the land cover types that have additional monitoring requirements to comply with the 4th Environmental Safeguard.

The i-Tree Canopy tool automatically calculates the confidence of the estimate of canopy cover. The effort of sampling with random points must continue until a confidence estimate for average canopy cover meets or exceeds +/-10% at one standard error. The points must be archived for the project life and made available to verifiers during verification. Table 2.3 displays an example of the data entry form that is found in CALCBOSK, which must be used for each project[3]; the Forest Owner would need to fill in the general information in the top row, along with the data for each individual point below.

Table 2.3. Example of Data Entry Format for each Point

Date of Image: (Day/Month/Year)			Date of Sample: (Day/Month/Year)	Analyst: (Name)
Point Number	Latitude	Longitude	Current Land Cover Type	Current Tree Canopy? (Y/N)
1	16°51'44.63 "N	97°53'30.07 "W	CO	Y
2	16°49'12.81 "N	97°47'44.70 "W	LA	Y
3	16°49'28.11 "N	97°47'41.76 "W	AG	N
4	16°49'31.21 "N	97°47'33.34 "W	AG	N

2.2 Project Eligibility and Calculating the Project Baseline

The sampled points enable an estimate of area (hectares) to be calculated for each land cover class, as well as the areas of land cover considered to be natural and not natural.

In some instances, vegetation types that are considered natural may be present in an unnatural proportion or distribution. For these cases, Table 2.2 of the Quantification Guidance presents both a natural vegetation type and a non-natural vegetation type. The Forest Owner/Project Developer must make the determination of whether a certain vegetation type is considered natural within the specific forest context and enter the point's classification into CALCBOSK accordingly.

For instance, grasslands are considered a natural vegetation type; however, in some instances grasslands may be present in an unnatural proportion due to human activities such as cattle

[3] Latitude and Longitude measurements are accepted as degrees or Universal Transverse Mercator (UTM) coordinates.

grazing. In these cases, the Forest Owner/Project Developer may select the "Grassland Non-natural" or "*Paztizales No-naturales*" vegetation type.

The Forest Owner/Project Developer would further need to justify the rationale behind defining a vegetation type as non-natural. In the case of non-natural grasslands, the Forest Owner/Project Developer would need to provide evidence for the cause of the non-natural presence of grasslands, such as the presence of grazing, and the risk of continued degradation of the forest due to this activity. Evidence should include a document explaining the cause of the non-natural landcover type and the assertion of continued risk within a reasonable extent to the natural landcover. The document should be signed by a CONAFOR certified Forest Technician that is familiar with and/or works in the area.

A project is eligible if the natural land cover found in the Project Area is less than 90% of the original (prior to human influence, i.e. natural) land cover, i.e. at least 10% of the land cover is no longer a natural land cover type.

These calculations are automated in CALCBOSK. The project baseline is calculated as the sum of the inventory in the required carbon pools in all Activity Areas included for crediting.

2.3 Ongoing Project Area Monitoring

To ensure project activities within the activity areas do not lead to reduced forest cover outside the activity areas, the same random set of points used to determine the project's baseline are also used to monitor changes in land cover and canopy cover prior to each 6th Reporting Period verification. Past photo images (Google Earth, etc.) may be used to further support the determination of land cover and management history; however, the most recent photo image must also be used to analyze current land cover. Exceptions are allowed with written approval from the Reserve.

3 Quantifying Carbon Stocks in Activity Areas

Quantification of Activity Areas requires an intensive approach to inventory that produces accurate estimates of the included carbon pools,[4] ensures permanence, and ensures compliance to environmental safeguards. An intensive inventory requires field sample plots to be installed, field measurements acquired, and the data input into CALCBOSK for analytical purposes.

3.1 Sampling Methodology for Activity Areas (Standing Live and Standing Dead Wood)

Inventory sample plots for developing a carbon inventory are only required for areas where trees will be inventoried for the purposes of generating credits, i.e. Activity Areas. Inventory sample plots are not required to be measured for non-Activity Areas. Monitoring for forest canopy cover is sufficient for monitoring non-activity areas.

Any portion of the Project Area can be added to the project in future years as an Activity Area for crediting following the establishment of an intensive inventory for the new Activity Area. Therefore, sampling activities can be staggered over time as management activities evolve and funding streams become available.

Where sampling is required, the sampling methodology is designed to achieve an unbiased inventory estimate with a target precision of +/- 20% at the 90% confidence interval for standing live and dead trees based on CO_2e estimates.

3.1.1 Inventory Sample Plots

A 25 by 25 meter grid of plot locations must be randomly placed on the Project Area. This will result in plots being associated with both Activity Areas and Non-Activity Areas. Only the plots within Activity Areas are subject to being selected randomly for field sampling. The grid will serve as a reference for plot locations throughout the project life. Therefore, as new stands are added as Activity Areas, plot locations will be readily available for selection for field measurements.

Plots are randomly selected from the pool of plots available in Activity Areas for sampling using the randomization utility within CALCBOSK. Achieving the overall sampling goal of +/- 20% at the 90% confidence interval will require a different number of plots based on the variability of stocking within the Project Area.[5] Forest Owners are responsible for estimating the number of plots needed to achieve the target confidence level. Alternatively, plots can be sampled in the order of their random selection until the desired confidence level is achieved. Once the plots have been selected, the inventory plots will be monumented for future re-measurement as part of ongoing monitoring. Additional plots may be added in the future in the order of their random selection at the project initiation in order to improve confidence estimates. A plot cannot be removed once it is part of the basis of the inventory[6]. CALCBOSK will calculate the inventory confidence from the project data.

Data from inventory plots are valid for a period of 12 years following field sampling, during which time the plot data can be updated with estimates of annual growth increment to both diameter

[4] See the Mexico Forest Protocol, Table 5.1 (GHG Assessment Boundary).
[5] No projects are accepted if the confidence is less than +/- 20% at the 90% confidence interval.
[6] The Reserve is contemplating future guidance to structure a randomized system of removing and replacing plots.

and height measurements. The process for updating plots is described in detail in Section 4. Since plot data can be no older than 12 years, plots must be periodically re-measured or new plots installed for both annual monitoring and periodic field verification. Any time more plots are desired for improving inventory confidence, new inventory plots must be selected randomly for measurement from the grid of potential plots described above. Plot data (not plot location) must be removed or replaced from the inventory when an event substantially changes the forest cover surrounding the plot, e.g. harvest or forest fire.

Inventory plots are installed as fixed radius plots. The size of the radius varies depending on the attribute that is measured, as shown in Table 3.1 below. Only the random plots selected for sampling need to be installed. Plot centers must be monumented so they can be relocated for future measurement or for verification. Monumenting plot locations so that they are available for re-measurement and/or verification can be challenging. GPS coordinates must be recorded for each plot at, or offset from, the plot center. Since GPS coordinates will only partially assist in relocating the plot center, additional navigational devices are necessary. It is recommended that an object be placed at plot center that is highly resistant to environmental features, including weather, animals, and fire. A small piece of metal rebar may be suitable. Relocating the plot center can be enhanced through the identification of bearing trees, or trees with aluminum tags affixed to them with a measured distance and compass bearing to the plot center etched or otherwise written on them. A minimum of two trees will assist in triangulating to the plot center. Marking these trees with highly visible paint will also be useful for plot center relocation. Table 3.1 displays the data that are to be collected at each inventory plot.

Table 3.1. Inventory Plots

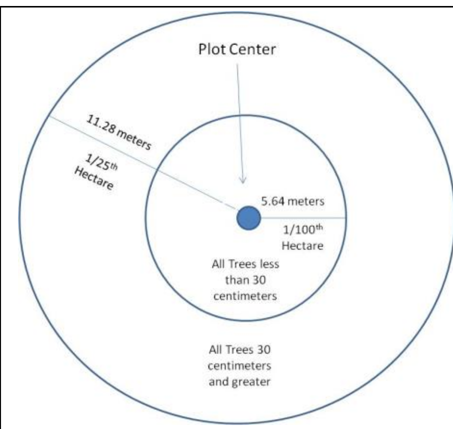
For Each Plot		
Item	**Attribute**	**Description**
1	Date of Plot Visit	Day/Month/Year
2	Latitude	From GPS
3	Longitude	From GPS
4	Plot Number	Enter the plot number for the plot, as described in the section above.
5	Inventory Personnel	Enter the initials of the inventory technicians responsible for measuring and recording data on the plot.
6	Slope	Using the clinometer, average the slope measurements looking uphill and downhill to the nearest 5%.
7	Aspect	Enter the degrees (azimuth) looking directly downhill from plot center.

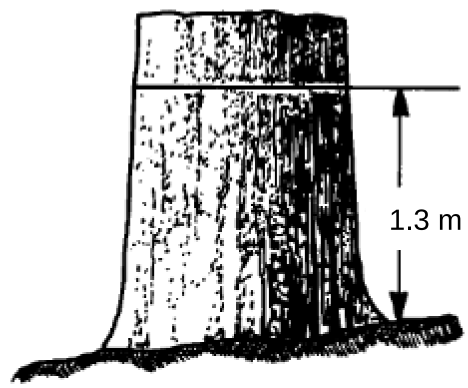
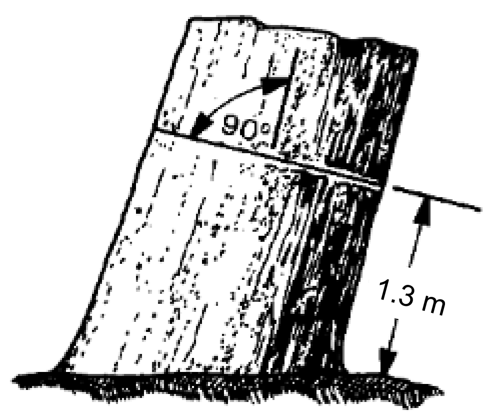
On a Fixed 1/25th Hectare Radius (Radius = 11.28 m), all trees ≥ 30 cm DBH and ≥ 3m height

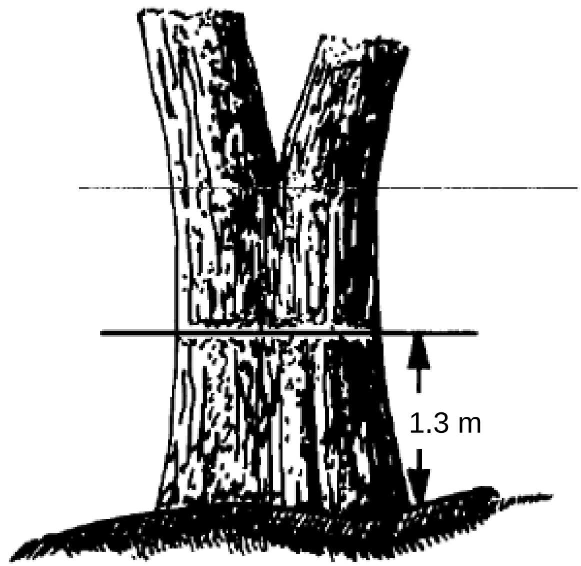
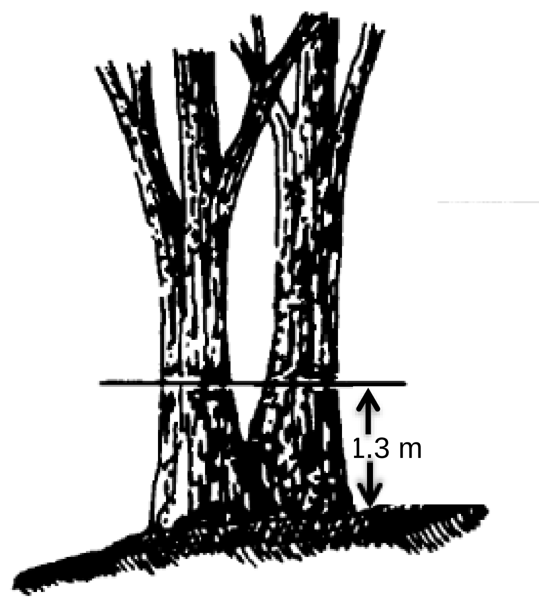
On a Fixed 1/100th Hectare Radius (Radius = 5.64 m), all trees ≥ 10 cm and < 30 cm DBH

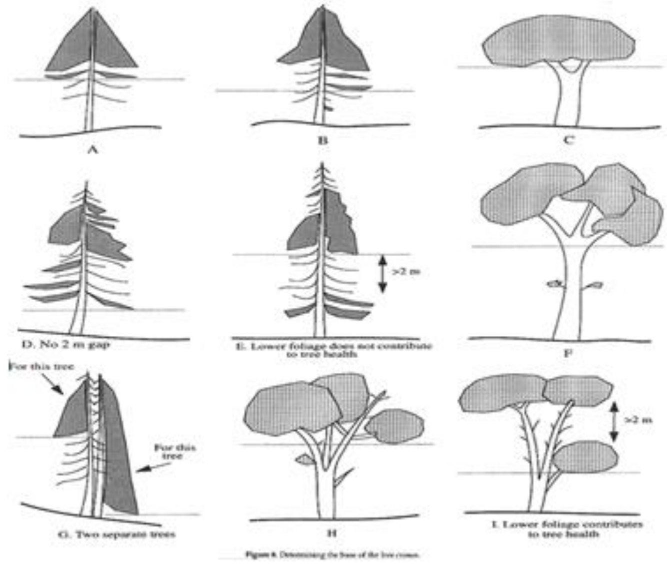
Radial measurements need to be corrected for horizontal distances based on the slope from plot center to each tree.

Note: the radial measurements are based on distances from plot center to the base of the tree.



Item	Attribute	Description
8	Tree Number	Trees are assigned a number 1 to X (for trees 30cm and greater) and a letter A to Z (for trees less than 30cm), starting from 0 degrees (North) and generally proceeding clockwise. The numbering convention in CALCBOSK facilitates the relocation and the verification of the trees. Over time, the numbering convention will breakdown as trees grow into plots and small trees with a letter designation grow into large trees with a numeric designation.
9	Species	Enter the species code for each species on the plot. The species code can be found for each species in the Inventory Field Manual.
10	DBH	Measure and record Diameter at Breast Height (DBH) to the nearest centimeter on every tree using a diameter tape and wrapping the tree at a height of 1.3 meters from the base of the tree on the uphill side. The guide here displays how uncommon trees should be measured (use uphill guidance).  

Item	Attribute	Description
		Forked trees above DBH are counted as one tree. Forked trees below DBH are counted as two trees (or however many forked stems exist). Add minimum DBH to be included.  One Tree  Two Trees *Images via FSH 2409.12 USDA Forest Service Timber Cruising Handbook*
11	Total Height	Measure of total height (height from base of tree to top) of all trees in the plot to the nearest meter. If the angle from level to the point of measurement exceeds 45 degrees (i.e., 100% or 66 topo), the distance from the measured tree must be increased to reduce the angle. For dead trees with broken tops, estimate the total height to the nearest meter by comparing the tree to other live trees of similar diameters and species.

<table>
<tr><th>Item</th><th>Attribute</th><th>Description</th></tr>
<tr><td>12</td><td>Height to Crown Base</td><td>

Measure the distance from the base of the tree to the ocularly balanced base of the tree’s crown. See examples above.</td></tr>
<tr><td>13</td><td>Vigor</td><td>For each tree, provide a rating of the tree’s apparent vigor. Determination of vigor is based on consideration of color of foliage, crown proportion and appearance, retention of leaves/needles, appearance of apical growth, length between growth whorls, and presence of cavities and fungal growth. The code is assigned based on the following classes:
<table>
<tr><th>Code</th><th>Description</th><th>Decay Adjustment (adjustment to wood density)</th></tr>
<tr><td>1</td><td>Very Healthy/Dominant: Crown is full on all sides and crown length is at least 30% of the tree’s length, or the total height of the tree (measured in step 11) minus the height to crown base (measured in step 12) divided by the total height of the tree is at least 30%. Tree crown is generally above other trees around it and it is experiencing minimum competition.</td><td>100%</td></tr>
<tr><td>2</td><td>Healthy/Codominant: Crown may not be full on all sides due to competition with neighboring trees, but has some portion of its crown in full sunlight. Crown is at least 20% of the tree’s length.</td><td>100%</td></tr>
<tr><td>3</td><td>Suppressed: Crown is generally below other trees and has some live foliage, but is on decline.</td><td>100%</td></tr>
<tr><td>4</td><td>Dead with moderate decay: Tree has no remaining foliage. Branches and top are mostly intact and bark is mostly attached to the tree.</td><td>75%</td></tr>
<tr><td>5</td><td>Dead with advanced decay: Tree may exhibit missing top, fungal bodies, missing bark. No remaining foliage exists on the tree’s crown.</td><td>50%</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Item</th><th>Attribute</th><th colspan="3">Description</th></tr>
<tr><td rowspan="4">14</td><td>Defect Estimate</td><td>Section of Tree</td><td>Standardized Portion of Biomass in each Section of Whole Trees</td><td>Actual Portion Remaining in each Section of Tree (Observed)
Example: 100% if portion is complete, 0% if portion is totally missing</td></tr>
<tr><td rowspan="3"></td><td>Top 1/3</td><td>10%</td><td>0 – 100%</td></tr>
<tr><td>Mid 1/3</td><td>30%</td><td>0 – 100%</td></tr>
<tr><td>Bottom 1/3</td><td>60%</td><td>0 – 100%</td></tr>
<tr><td>15</td><td>Previous 5 years' radial increment</td><td colspan="3">These data are used to estimate growth in the forest. This is required in the absence of repeated plot measurements or a viable growth model for each species.

Enter the measurement (millimeters) of the past 5-years' radial growth (from a ring count) on a 'highly or moderately vigorous' tree (vigor codes 1 or 2) and a 'low vigor' tree (vigor code 3; if present) in the plot; select the first feasible trees (some species may not be suitable for measurement) facing north and continuing clockwise.</td></tr>
</table>

3.2 Calculating the Project Carbon Inventory and Confidence Statistics in Standing Live and Dead Trees

This section provides a step-by-step approach to calculating the project's carbon inventory in standing live and dead trees. This section applies only to the inventory estimates within the Activity Areas. Developing forest carbon estimates from sampling in the Activity Areas must be done according to the following general steps:

1. Calculating the net carbon tonnes for standing live and dead trees on a per hectare basis for each plot.
2. Determining the average net carbon tonnes for standing live and dead trees by summing the plots and dividing by the number of plots represented.
3. Summing the carbon tonnes for the Activity Area.
4. Calculating the project sampling error and confidence deduction.

The plot data used to calculate the inventories must represent current conditions at the time the inventory is created. The process for updating forest inventories is discussed in Section 4. Volume, biomass, and carbon are to be calculated for each tree sampled in the plots. Volume and density equations are provided in a reference file for each tree based on the tree's measured diameter and height. The biomass estimates calculated for each tree are adjusted based on the defect noted for each tree during inventory sampling. The net biomass is converted to carbon tonnes and expanded to a per hectare basis, as shown in Table 3.2. These calculations are automated in CALBOSK.

Table 3.2. Calculate the Carbon Tonnes for each Plot on a per Hectare Basis

Steps	Description	Tools/Process Required	
1	Calculate the cubic volume in each tree.	Formula provided in CALCBOSK manual. Formulas provided will enable volume to be calculated for all portions of the tree.	
2	Calculate the biomass tonnes in each tree.	Formula provided in CALCBOSK manual.	
3	Adjust the tree's biomass based on defect percentages assigned to each tree.	Defect – Bottom 33%	60% **x** biomass tonnes in gross tree (Step 2) **x** Defect% (Bottom 33%)
		Defect – Middle 33%	30% **x** biomass tonnes in gross tree (Step 2) **x** Defect% (Middle 33%)
		Defect – Top 33%	10% **x** biomass tonnes in gross tree (Step 2) **x** Defect% (Top 33%)
		Sum Defect	Sum of biomass defect from each step above
		Adjusted Biomass	Biomass (Step 2) – Sum Defect
4	Calculate the carbon tonnes in each tree.	Adjusted Biomass (Step 3) **x** 0.5	
5	Calculate adjustment for decay.	Multiply the tree by the decay adjustment above.	
6	Expand the carbon estimate in each tree to a per hectare basis.	Multiply the carbon estimate in each tree by the weight required to represent the estimate on a per hectare basis: 25 **x** Carbon Tonnes (Step 5) for trees sampled in 1/25th hectare radius 100 **x** Carbon Tonnes (Step 5) for trees sampled in 1/100th hectare radius	

The individual tree estimates within each Activity Area are summed within each plot and expanded to a per-hectare value. Subsequently, the plot estimates are averaged to obtain a mean estimate for each Activity Area. These Activity Area estimates are then expanded to the project based on the area representation (hectares), as shown in Table 3.3.

Table 3.3. Determine the Carbon Tonnes for each Project Area and for the Project

Steps	Description	Tools/Process Required
7	Calculate the average carbon tonnes per hectare in Activity Area X.	Sum the carbon estimates from each plot within Activity Area X on a per hectare basis and divide by the number of plots in Activity Area X.
8	Calculate the total carbon tonnes in Activity Area X.	Multiply the average estimate of carbon tonnes per hectare by the total hectares represented by Activity Area X in the project.
9	Calculate the total carbon tonnes in the project.	Repeat Step 7 for each Activity Area and sum the estimates of each Activity Area to get total carbon stocks for the project.

The desired sampling error for the Activity Areas is +/- 5% of the mean at the 90% confidence interval. Project data will be accepted with sampling errors up to +/- 20% of the mean at the 90% confidence interval; however, deductions for uncertainty are applied. The uncertainty deduction is applied directly to the project inventory of live and dead trees, but not to the baseline estimate, in order to ensure a conservative quantification of project benefits.

Credits that are withheld from transactions due to the uncertainty deduction can be recouped when increased sampling effort (usually the addition of more plots) improves the confidence estimate of the inventory. Likewise, inventory estimates that decrease in confidence will result in a reduction of credits available for transaction, which can result in an apparent reversal. In the event of an apparent reversal due to the application of a confidence deduction, the Forest Owner will have one year to correct the inventory estimate. If the sampling error has not been corrected in the course of the year, the project must compensate for the reversal per the guidance on reversals (Mexico Forest Protocol, Section 9).

Table 3.4. Calculate the Sampling Error for the Estimate and Apply the Confidence Deduction

<table>
<tr><th>Steps</th><th colspan="2">Description</th></tr>
<tr><td>10</td><td colspan="2">The sampling error, calculated at the 90% confidence interval, is calculated automatically in CALKBOSK.</td></tr>
<tr><td rowspan="4">11</td><td>Actual Project Sampling Error at 90% Confidence Level</td><td>Confidence Deduction</td></tr>
<tr><td>≤ 5%</td><td>0%</td></tr>
<tr><td>> 5% - ≤ 20%</td><td>Actual sampling error % – 5%
(to the nearest 1 percent)</td></tr>
<tr><td>> 20%</td><td>100%
(Account is suspended until corrections are made)</td></tr>
</table>

3.3 Inventory Standards for Projects Participating in an Aggregate

Forest Owners enrolled in an aggregate may submit project inventories with reduced sampling requirements based on the statistical principle that the targeted standard error (+/- 5 percent of the mean at the 90 percent confidence level) is achieved across the entire aggregate.

For aggregated projects, the sampling error allowed for inventory data associated with individual forest projects varies on a sliding scale based on the number of participating projects. This sliding scale was determined through consultation with statisticians and affirmed by a model exercise as described in Appendix A of the Reserve Guidelines for Aggregating Forest Projects Version 1.1. The target sampling error for the individual projects ranges between 7 to 20 percent of the mean at the 90 percent confidence level based on the total number of projects in the aggregate as shown in Table 3.5 below. The same targeted sampling error applies to all projects in an aggregate.

Table 3.5. Target Sampling Error at the 90% Confidence Level for Projects Participating in an Aggregate

Number of Participating Projects in the Aggregate	Target Sampling Error (TSE)
2	7%
3	8%
4	9%
5	10%
6	11%
7	12%
8	13%
9	14%
10	15%
11	16%
12	17%
13	18%
14	19%
15+	20%

For projects in an aggregate, confidence deductions are determined according to Table 3.6 (using the appropriate TSE from Table 3.5), below, rather than Table 3.4.

Table 3.6. Inventory Confidence Deductions for Participating Projects in an Aggregate

Actual Sampling Error at 90% Confidence Level	Confidence Deduction
0 - TSE%	0%
TSE to 20%	(Actual sampling error – TSE %) to the nearest $1/10^{th}$ per cent
Greater than 20%	100%

Using this approach, the Reserve’s inventory standard remains essentially the same for single large projects and aggregated groupings of smaller projects while allowing the smaller projects in an aggregate to benefit from reduced costs associated with the reduced number of plots required per project. The underlying statistical rationale for this approach is explained in Appendix A of the Reserve Guidelines for Aggregating Forest Projects Version 1.1.

4 Updating Project Carbon Inventories and Determining Actual Onsite Carbon Stocks

Since project forest carbon stock estimates are constantly fluctuating due to additional inventory data, forest growth, harvest, and natural disturbances, estimates of forest carbon stocks must be updated and reported annually. The annual adjustments to inventory data are based on the inclusion of new information, adjusting existing data for forest growth and disturbances, and recalculating the carbon estimates and the confidence deduction.

Monitoring consists primarily of updating and reporting a project forest carbon inventory for the Activity Areas and monitoring trends of forest carbon stocks for the entire Project Area.

The inventory of Activity Areas is based on inventory sample plots and/or modeled increment (up to 12 years old) of diameter and height for planted stands. Monitoring also includes tracking data related to social and environmental safeguards to ensure compliance. Each step is described in greater detail below.

4.1 Updating Forest Inventory Data Based on New Information

For the Active Areas, any plots sampled or re-sampled in the past year must be incorporated into the project inventory. If a plot is re-measured, the old data must be replaced with the new data in terms of representing the plot's inventory. Plot data is valid for 12 years, at which point the plot must be re-measured. The project inventory therefore must be based on plots sampled within the 12-year period. Forest Owners may decide to perform all of their inventory sampling in a given year or distribute it throughout the 12-year timeframe.

4.2 Updating Forest Inventory Data for Growth

Updating tree records is based on applying an appropriate diameter increment and a height increment to each tree record in CALCBOSK. There are three acceptable methods for updating the tree records:

1. Through the use of forest growth models that have been supported by reliable publications, repeated measurements, local knowledge, or regional and/or national CONAFOR offices. A model can be growth simulations in a computer or simply documented rates of diameter and/or height data. The models must be appropriate for the environmental conditions and species present on the project.
2. Through the use of a stand table projection. The guidance for adding annual diameter and height increment is based on diameter increment measurements taken at plots and regression analysis for heights. The steps involved are displayed in Table 4.1 CALCBOSK provides a function to automate the annual updating of inventory data.
3. Through the use of CONAFOR-approved modeled projections of diameter and height increments for stands up to 12 years old, appropriate for the species present in the Activity Area, the stocking levels, and the site class.

Table 4.1. Steps for Updating Tree Records in CALCBOSK using a Stand Table Projection

Steps	Description	Tools/Process Required
1	Querying data for analysis.	Query live tree records by the size class, species, and position of the tree in the stand that have been measured for increment. (CALCBOSK assigns size classes to inventory data.)
2	Determine annual diameter increment.	The previously collected data for diameter increment (see item 16 in Table 3.1 Inventory Plots) represent the increment over the previous 5 years. This data must be divided by 5 to determine the average annual diameter increment.
3	Calculate average annual diameter increment.	The average annual diameter increment by species and size class is calculated by summing the results from Step 2 for each species and size class and dividing by the number of records summed.
4	Add diameter increment to tree records.	The average diameter increment for each species and size class is multiplied by the number of years that have passed since the tree record was measured in the field and added to the original diameter estimate to update the diameter estimate to a current reporting year.
5	Calculate a diameter-to-height regression estimator.	Using only original measured data (not updated data), a regression formula is developed by inserting the measured diameter and height data by species into a spreadsheet (e.g. Microsoft Excel) and using either a logarithmic or linear function depending on which estimator provides the best R^2 value.
6	Calculate the estimated height for each tree based on the regression estimator from Step 5.	Apply the regression formulae developed in Step 5 for each species to the updated diameter (Step 4) to calculate an estimated height for each tree.

A review of the forest cover of the Project Area must be conducted on an annual basis to determine changes in forest cover. This report must be prepared and submitted with each monitoring report.

4.3 Updating Forest Inventory Estimate for Harvests and/or Disturbances

Plots that are geographically situated in areas that experienced forest cover class-changing harvests and/or natural disturbances in the previous year must be excluded from the inventory analysis until the plots are updated with re-measured data from field visits. No more than 5% of the total inventory plots used to derive the inventory estimate can be excluded at any one time and a plot cannot be excluded for a period of time greater than one year.

4.4 Completing the Annual Update Process

Upon updating the height and diameter increments, the land use and forest cover classes for disturbances, and the Activity Area (hectare) assignments in CALCBOSK, the forest carbon stocks can be recalculated using the methods identified in Section 3. The confidence statistics and the associated confidence deduction may only be updated in the Carbon Monitoring Worksheet if it has been reviewed and approved by a verifier.