Forest Sector Protocol

Version 2.1

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Abbreviations and Acronyms

C	carbon
CARROT	Climate Action Registry Reporting Online Tool
CDF	California Department of Forestry and Fire Protection
CH_4	methane
CO_2	carbon dioxide
FPA	California Z'Berg-Nejedly Forest Practices Act
FPP	Forest Project Protocol
FSP	Forest Sector Protocol
GHGs	greenhouse gases
GRP	general reporting protocol
HFC	hydrofluorocarbon
Lb.	pound
N_2O	nitrous oxide
PFC	perfluorocarbon
Registry	The California Climate Action Registry
RPF	registered professional forester
SF_6	sulfur hexafluoride
WRI	World Resources Institute

Forest Protocol Key Terms

Activity-shifting leakage: The displacement of activities from inside the project's physical boundaries to locations outside of the project's boundaries as a direct result of the project activity.

Additionality: Forest project practices that exceed the baseline characterization, including any applicable mandatory land use laws and regulations.

Allometric equation: An equation that utilizes the genotypical relationship among tree components to estimate characteristics of one tree component from another. Allometric equations allow the below ground root volume to be estimated using the above ground bole volume.

Biological emissions: For the purposes of the forest protocol, biological emissions are GHG emissions that are released directly from forest biomass, both live and dead, including forest soils. In the first three years of reporting the only biological emission type that is required to be reported for forest entities and projects is CO_2, as identified in the Quantification Section of the protocol. Biological emissions are deemed to occur when the reported tonnage of carbon stocks decline at the project or entity level in comparison to the reported tonnage of the previous year.

Biomass: The total mass of living organisms in a given area or volume; recently dead plant material is often included as dead biomass.[1]

Bole: A trunk or main stem of a tree. For the purposes of the Protocol, any tree bole with a minimum diameter of three inches should be included in the inventory to estimate carbon stocks.

Carbon pool: A reservoir that has the ability to accumulate and store carbon or release carbon. In the case of forests, a carbon pool is the forest biomass, which can be subdivided into smaller pools. These pools may include aboveground or below-ground biomass or roots, litter, soil, bole, branches and leaves, among others.

Carbon stocks: The carbon contained in identified forest biomass categories (i.e., carbon pools), such as above and below ground biomass, at a specific point in time.

Verification: The process used to ensure that a given participant's greenhouse gas emissions or emissions reductions has met the minimum quality standard and complied with the Registry's procedures and protocols for calculating and reporting GHG emissions and emission reductions.

Conservation: Specific actions that prevent the conversion of native forest to a non-forest use, i.e., residential or commercial development or agriculture. This activity is also a type of project that may be registered in the Registry.

Conservation-based forest management: The natural forest management of native forest where commercial and/or noncommercial harvest and regeneration are practiced. This activity is also a type of project that may be registered in the Registry.

[1] Climate Change 2001, mitigation; Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change

Direct emissions: Greenhouse gas emissions from sources that are owned or controlled by the reporting entity.

Entity: The basic unit of participation in the Registry, which includes a corporation or other legally constituted body, and city or county, and each state government agency.

Entity non-biological baseline: Datum against which a forest entity can measure its non-biological GHG emissions.

Equity Share: Fractional percentage or share of an ownership interest.

Forest : Lands that support, or can support, at least 10 percent tree canopy cover and that allow for management of one or more forest resources, including timber, fish and wildlife, biodiversity, water quality, recreation, aesthetics and other public benefits.

Forest entity: An entity, as defined in this section, including a private individual that owns at least 100 acres of trees

Forest entity baseline qualitative characterization: A 100-year projection of the forest entity's management practices.

Forest management: The commercial or noncommercial harvest and regeneration of forest.

Forest project: A planned set of activities to remove, reduce or prevent carbon dioxide emissions in the atmosphere by conserving and/or increasing on-site forest carbon stocks.

Forest project baseline qualitative characterization: A long-term projection of the forest management practices (or absence thereof) that would have occurred within a project's boundaries in the absence of the project. Such baseline projections shall be based on the policy guidance, provided by project type, in the Forest Project Protocol and shall serve as the basis for quantifying the project's baseline.

Forest project greenhouse gas reduction: Removals or reductions of CO_2 and prevented CO_2
emissions resulting from Registry-approved forest projects. Greenhouse gas reductions are calculated as gains in carbon stocks over time relative to the project baseline.

Greenhouse Gases: (GHG) For the purposes of the Registry, GHGs are the six gases identified in the Kyoto Protocol: Carbon Dioxide (CO_2), Nitrous Oxide(N_20), Methane(CH_4), Hydroflourocarbons (HFCs), Perflourocarbons (PFCs), and Sulphur Hexafluoride(SF_6).

Greenhouse gas reduction: *see Forest project greenhouse gas reduction*

Lying dead biomass: Any piece(s) of dead woody material, e.g., dead boles, limbs, and large root masses, on the ground in forest stands. The Registry requires the carbon in lying dead biomass with a minimum diameter of 6 inches to be measured.

Management control- the ability of an entity to govern the operating policies of another entity or facility so as to obtain benefits from its activities

Market Leakage: The creation of greenhouse gas emissions outside of a project's boundaries through substitution or replacement due to the project activity impacting an established market for goods.

Material Misstatement: When a forest entities calculated C stocks and emissions for its forest project differs from the verifiers calculations by more than 15%. Projects that contain material misstatements will not be verified.

Native: Forests classified in the 1988 edition, or its approved successor equivalent, of " A Guide to Wildlife Habitats of California," published by the California Department of Fish and Game, and forests that are composed of the forest types within those classifications.

Natural forest management: Forest management practices that promote and maintain native forests comprised of multiple ages and mixed native species in the overstory and understory.

Natural significant disturbance: Any natural impact on a project's or entity's selected carbon pools that results in a loss of at least 20% of total carbon stocks.

Non-biological emissions: Greenhouse gas emissions that are not directly released from biomass. For example, GHGs from fossil fuel combustion qualify as non-biological emissions.

Offset: Discrete GHG reductions used to compensate for (i.e. offset) GHG emissions elsewhere, for example to meet a voluntary or mandatory GHG target or cap. Offsets are calculated relative to a baseline that represents a hypothetical scenario for what emissions would have been in the absence of the mitigation project that generates the offsets. To avoid double counting the reduction giving rise to the offset must occur at sources or sinks not included in the target or cap for which it is used.[2]

Optional reporting: Greenhouse gas reporting results that are reported to, but not verified by, the Registry.

Project developer: An entity that undertakes a project activity, as identified in the Forest Project Protocol. A project developer may be an independent third party or the forest entity.

Reforestation: The establishment and subsequent maintenance of native tree cover on lands that were previously forested, but have had less than 10% tree canopy cover for a minimum time of ten years. This activity is also a type of project that can be registered in the Registry.

Sequestration: The process of increasing the carbon content of a carbon reservoir other than the atmosphere. Biological approaches to sequestration include direct removal of CO_2 from the atmosphere through land-use changes[3] and changes in forest management.

Standing dead biomass: Standing dead tree or section thereof, regardless of species, with minimum diameter of three inches.

[2] World Resources Institute "The Greenhouse Gas Protocol: A corporate accounting and reporting standard (Revised edition)" (2004).
[3] Climate Change 2001, mitigation; Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change

Tree: A woody perennial plant, typically large and with a well-defined stem or stems carrying a more or less definite crown with the capacity to attain a minimum diameter at breast height of 3 inches and a minimum height of 15 feet at maturity with no branches within 4.5 feet of the ground.

Forest Sector Protocol

Reporting Biological Carbon Stocks and CO_2 Emissions from Forest Entities

I. Introduction

There is a growing interest among corporations, governments, policy makers, environmentalists, and citizens to combat the negative impacts associated with climate change. As a result, increasing number of companies are interested in reducing or offsetting their greenhouse gas (GHG) emissions, thereby decreasing their environmental risk, and becoming more sustainable. Entities, including forest entities, cannot manage what they do not measure. By creating a California or nation-wide GHG footprint via an annual inventory, you have a tool that can help you to manage your biological carbon stocks and greenhouse gas emissions more effectively in the future, which can generate multiple environmental benefits. The California Climate Action Registry's Forest Sector Protocol (FSP) is designed for forest entities to do this.

A forest entity's total GHG emission inventory will include reported information about its non-biological and biological forest carbon stocks and emissions. Guidance for reporting these types of emissions is provided in the California Climate Action Registry's (the Registry) General Reporting Protocol (GRP) and FSP respectively. The Forest Sector is similar to other sectors, as it may have GHG emissions that result from processes that involve fossil fuel combustion (i.e. non-biological emissions), such as the use of harvest equipment and transportation.

However, the forest sector is distinct from other sectors, as it also has GHG emissions that are released directly from forest biomass (i.e. biological emissions). While you should follow the Registry's GRP to report your non-biological emissions, you must also follow the FSP to report your forest carbon stocks and biological emissions. The FSP is written for forest entities and provides reporting standards for forest entities to compile, estimate, and report their forest carbon stocks and biological carbon dioxide (CO_2) emissions to the Registry for verification.

This document is organized in nine parts: Part I introduces the FSP, forest entity reporting, and discusses basic concepts and reporting criteria; Parts II - IV are designed to help forest entities identify and establish their geographic, organizational and operational boundaries; Part V provides guidance to forest entities who wish to establish an entity level biological baseline; Part VI provides the steps necessary to quantify an entity's biological carbon stocks and its baseline, as well as its emissions; Part VII outlines the verification process; Part VIII provides guidance on the reporting process; and Part IX is a section of Annexes that provide reporting worksheets that correspond with the Parts of the Protocol, as well as additional supporting information and references.

A. About forests, carbon dioxide and climate change

Forests have the capacity to both emit and sequester carbon dioxide, a lead greenhouse gas (GHG) that contributes to climate change. Trees, through the process of photosynthesis, naturally absorb CO_2 from the atmosphere and store the gas as carbon in its biomass, i.e., trunk (bole), leaves, branches, and roots. Carbon is also stored in the soils that support the forest (i.e. forest soil), as well as the understory plants and litter on the forest floor.

When trees are disturbed, through events like fire, disease or harvest, they emit their stored carbon as CO_2 into the atmosphere. The quantity of CO_2 that is emitted over time may vary, depending on the particular circumstances of the disturbance. Thus, depending on how forests are treated, they may be a net source or a net reservoir of CO_2. In other words, they may have a net negative or net positive impact on the climate. Currently, forests are the second largest source of global anthropogenic CO_2 emissions, largely due to deforestation.[4] However, through proper management and protection, forests can also play a positive and significant role to help address global climate change. The California Climate Action Registry's (the Registry) Forest Protocols are designed to address the forest sector's unique capacity to both store and emit CO_2 and to facilitate the positive role that forests can play in climate change.

B. Biological vs. Non-biological Emissions

As you read through this document, you will notice that the Registry distinguishes biological emissions from non-biological emissions. Biological emissions are GHGs that are directly released from biomass, both live and dead. In the case of forests, biological emissions are those resulting from the forest carbon pools identified in Section VI and are considered emissions if an entity's total carbon stocks decline from one year to the next. Non-biological emissions are those GHG emissions that are not released directly from biomass. Thus, these emissions may result from fossil fuels and their combustion. This distinction is helpful for analysis and the application of the protocol guidance.

C. GHG Reporting Scope

As indicated earlier, the current focus of the FSP is entity-level reporting of forest carbon stocks and CO_2 emissions. Similar to the reporting requirements of non-biological emissions in the main GRP, the Registry requires all forest entities to report, at a minimum, their entity level C stocks and CO_2 emissions for the first 3 years of reporting. By the fourth reporting year, an entity is required to report all other relevant GHGs: methane (CH_4), nitrous oxide (N_2O), perfloroucarbons (PFCs), hydrofloroucarbons (HFCs), and sulfur hexaflouride (SF_6). Of these gases, only N_2O and CH_4 are the only likely gases that are relevant for reporting. The Registry encourages you to report CH_4 and N_2O for your entity as early as possible. While the FSP does not currently provide its own explicit methodologies for reporting these GHGs, it does provide references that reporters may use in order to characterize these sources (see Section VI, Part K of the Forest Sector Protocol).

D. Forest Entity vs. Forest Project Reporting

The following are instances when a Registry member will use this guidance to report its biological emissions inventory to the Registry:

[4] Dixon R.K., et al. "Carbon pools and flux of global forest ecosystems". Science 263: 185-190 (1994).

1) If an entity wishes to report its California or nation-wide biological emission inventory (only state-wide information is verifiable at this time) along with its non-biological emission inventory

2) If an entity wishes to report a Registry-approved forest project (forest project), as it must also report its entity-wide California biological emissions inventory

Forest Entity Reporting:

There are two levels of reporting forest C stocks and biological emissions to the Registry: entity and project-level reporting. A forest entity may be an individual, a corporation or other legally constituted body, a city or county or a state government agency that owns at least one hundred acres of trees.[5] Entity-level reporting reflects all GHG emissions data, both biological and non-biological. This level of reporting is meaningful because it provides stakeholders with an overview of an organization's entire emissions and serves as a reference to evaluate future emission trends within the organization. In the case of forest entities, entity-wide reporting can provide an overview of its emissions, not only from their forests, but from their other operations as well, such as manufacturing and electricity use.

Forest Project Reporting:

Compared to entity-wide reporting, project-level reporting is more focused. It concentrates on forest carbon stocks and biological CO_2 emissions, and projects may either represent a geographic subset of a forest entity's total forestland area or occupy all of the entity forest area projects may be a smaller forest area within your forest entity. For the purposes of the FPP, a forest project is a planned set of activities to remove, reduce or prevent CO_2 emissions in the atmosphere by conserving and/or increasing on-site forest carbon stocks in a defined geographic area. Forest projects that adhere to the FPP will qualify for verified GHG reductions in the Registry.

To implement a forest project, you must consult the Registry's Forest Project Protocol (FPP). The FPP is a separate document that provides guidance and standards for how entities can report forest projects to the Registry. Currently, three types of forest projects may be reported and verified in the Registry:

Conservation-based Forest Management Projects: Forest projects that are based on the commercial or noncommercial harvest and regeneration of native trees and employs natural forest management practices

Reforestation Projects: Forest projects that are based on the restoration of native tree cover on lands that were previously forested, but have been out of tree cover for a minimum of ten years

Conservation Projects: Forest projects that are based on specific actions to prevent the conversion of native forests to a non-forest use, such as agriculture or other commercial development

For further information on the differences between forest project (Forest Project Protocol) and entity (Forest Sector Protocol) reporting please see the comparison chart in Annex D.

[5] At this time, forest entities may not aggregate to report their data. The Registry may consider this option at a later date.

E. Verification of Carbon Stocks and Biological Emissions

Verification scope

Pursuant to legislation, The Registry requires third party verification of forest biological inventories reported for California only at this time. Third party verification provides additional credibility and standardization to the results reported to the Registry. While, California results may only be verified, the Registry encourages forest entities to calculate and report their nation-wide forest carbon stocks and biological emissions as optional reporting. Although these will not be verified by the Registry at this time, nationwide reporting will promote better understanding and management of the carbon risks and opportunities within forest entities.

Verifier criteria
All California biological emission inventories reported to the Registry must be verified by a State and Registry approved forest sector verifier. Forest Sector Verifiers are verifiers that have qualified to serve as general verifiers who also have expertise in the forest sector. The verification process is the same as described in the Registry's General Verification Protocol, with the addition of forest-specific assessments and checklists. Part VII of this FSP describes the forest-specific verification activities. In addition, General Verification Protocol describes the forest-specific process in detail.

F. Overview of the Forest Entity Reporting Process:

The four basic procedural steps to Forest Entity reporting are listed below. The remainder of the Forest Sector Protocols explains in detail how these steps should be undertaken. In addition you must refer to the Registry's General Reporting Protocol for information on how to report non-biological emissions and the Forest Project Protocol to report projects.

1. Establish entity boundaries, baselines and reporting responsibility
2. Collect and estimate carbon inventory information by the end of the first reporting year
3. Report entity activity
4. Verify entity activity

After reporting your entity's carbon stocks for the first year, you will need to complete the following steps on an ongoing basis until the project is completed:

1. Report entity C stocks annually
2. Verify non-biological emissions annually
3. Verify biological C stocks and CO_2 emissions in years 1 and 6 of the verification cycle.
    A. Submit annual entity monitoring reports to the Registry
    B. Perform verification of C stocks at specified intervals

G. Reporting Deadlines

The Registry requires forest entities to follow the same annual reporting and verification deadlines for their biological forest emissions as identified in the GRP. The reporting and verification deadlines are listed below:

- ***Entity Reporting year***: January 1 - December 31

- ***Entity Reporting deadline***: August 31 of the year following the reporting year
- ***Entity Verification deadline***: December 31 of the year following the reporting year

H. Protocol Questions and Comments

All of the Registry's protocols are available on its web-site: www.climateregistry.org/protocols (General Reporting and General Verification Protocols) and www.climateregistry.org/protocols/industry (industry-specific protocols, such as the forest protocols). If you have difficulty accessing any of the documents, please call 213-891-1444.

The Registry's reporting and verification protocols are designed to be compatible with one another. Should you encounter a conflict between any of the documents, or if you have questions about carrying out the steps described herein, please contact the Registry at: 213-891-1444 or help@climateregistry.org.

The Registry welcomes and encourages Registry members, verifiers, TA's, and the public to comment on its protocols, program, quality, and usefulness of data at any time. The Registry values all feedback on how to improve and continue to develop its program.

If you have a comment or suggestion that you would like to formally submit to the Registry for consideration, please complete a Protocol Comment Form, available at www.climateregistry.org/Protocols and submit your comment for consideration. The Registry will post all comments on its website for public review and response.

The Registry may update the FSP, FPP and the FCP occasionally to reflect new scientific findings or policy direction. The Registry will notify all forest entities and approved forest verifiers when it updates the forest protocols.

The current versions of all protocols pertaining to forest entities and projects will be available on the Registry's web-site: www.climateregistry.org/protocols/industry.

II. Geographic Boundaries

Identify the Geographic Scope of Your Carbon Stock and Biological Emissions Inventory

At the entity level, you must identify the geographic scope for which you will report your entity's forest carbon stocks and biological emissions. Please review the following information for further explanation and refer to the corresponding Forest Entity Summary Worksheet in Annex A to fill in the appropriate information.

A. California-only or nationwide reporting

As a forest entity, you have the option to define the scope of your carbon stock and biological emissions inventory in two ways. You may choose to report:

- All of your forest C stocks and biological emissions in California, which are verifiable; or
- All of your forest C stocks and biological emissions and C stocks in the US--separated into California and non-California biological inventories. Please note: the Registry considers all non-California biological inventories as optional, which means they will not be verified by the Registry

As noted above, if you estimate and report your carbon stocks and biological emissions (biological inventory) at the national level, you must verify your biological inventory from California. Your biological inventory outside of California cannot be verified at this time, though it may be optionally reported. The verified California inventory information will appear in your "annual report" (required information), whereas the non-California inventory information will appear in your "optional report," both of which are viewable by the public via the Registry's CARROT (Climate Action Registry Reporting Online Tool).

The Registry plans to consider options to expand verified reporting for biological emissions in the future. In the meantime, you may gather and report nationwide biological emission inventories for potential nationwide verification in subsequent years. If you choose to do so, the Registry encourages you to follow the guidance and methodologies provided in its protocols.

III. Organizational Boundaries

Identify Organizational Boundaries and Responsibility for Reporting Entity C Stocks and Biological Emissions

To report forest carbon stocks and biological emissions to the Registry, you must identify the organizational boundaries for the stocks and emissions that fall within your identified geographic reporting boundaries. Organizational boundaries refer to an entity's share of ownership or control of the sources (or potential sources) of biological emissions and forest carbon stocks that fall within an entity's chosen geographic boundaries. In the case of a forest entity, the sources attributable to biological emissions and C stocks are the trees.

Please use the Entity Summary Worksheet in Annex A to identify your organizational boundaries.

For purposes of the Registry, the legal owner of the commercial and noncommercial trees is responsible for reporting the biological emissions and C stocks associated with the trees. If the owner owns 100% of the trees (i.e. ownership is not shared), the owner is responsible for reporting the carbon stocks and any emissions associated with those trees. If the legal ownership of the trees is shared, the Registry *strongly recommends* reporting based on equity share. However, the owner has two options for reporting:

Option 1 – Management Control: Report based on whether you hold management control of the trees/business activity

Option 2 – Equity Share: Report based on a fractional percentage or share of ownership interest in the trees

Please also keep in mind that the approach to reporting should be consistent with the reporting of non-biological emissions pursuant to the GRP and any forest projects reported pursuant to the FPP.

Example A: Organizational Boundaries Example

The "Timber Company of Mendocino" (TCM) owns 20,000 hectares of forested land (i.e. land with at least 10% tree canopy cover). TCM is the sole owner pursuant to the land title and has not transferred any rights to its trees to another entity. Thus, the 20,000 acres of forested land represents the organizational boundaries for TCM's carbon stocks and biological emissions. Since TCM is the sole owner of the forest, TCM is responsible for reporting the carbon stocks and any biological emissions associated with these trees.

IV. Operational Boundaries

Determine operational boundaries through identification of forest carbon pools

In addition to organizational boundaries, you must identify the operational boundaries for your forest C stocks and biological emissions. Operational boundaries are defined as, "the boundaries that determine the direct and indirect [forest carbon stocks and biological] emissions associated with operations owned or controlled by the reporting company".[6] Direct emissions refer to those carbon stocks and GHG emissions that are either controlled or owned by the reporting entity, while indirect emissions refer to those that occur due to the reporting entity's actions, but are produced by sources owned or controlled by another entity.[7]

The Registry requires entity's to identify only the boundaries that determine an entity's direct forest carbon stocks and biological emissions. These boundaries relate to the forest

[6] World Resources Institute "The Greenhouse Gas Protocol: A corporate accounting and reporting standard (Revised edition)" (2004).
[7] id

categories or forest carbon pools that may either accrue carbon stocks or, through their loss of carbon, cause CO_2 emissions. On a broad level, these pools are 1) aboveground live forest biomass; 2) below-ground live forest biomass; 3) dead forest biomass; and 4) forest soil. However, these categories can be further subdivided into smaller carbon pools, as they are in the following paragraphs.

The Registry has identified a set of direct carbon pools that all forest entities are required to identify, inventory and report. These required direct carbon pools are listed below, in addition to a set of optional direct carbon pools that an entity may also choose to identify, inventory and report. Please note, it is recognized that verain required pools may not exist for entities during verain reporting years. In these instances, they do remain required pools for entities, though the carbon stocks to report for the pool would be zero.

Required Carbon Pools (Direct):

1) Tree biomass
2) Standing dead biomass
3) Lying dead wood

The Registry recognizes other direct carbon pools as *optional reporting*. While optional carbon pools will not be verified, they may also be reported to the Registry, and they are as follows:

Optional Carbon Pools (Direct):

1) Herbaceous understory and shrubs
2) Soil
3) Litter and duff
4) Wood products

Example B: Operational Boundaries Example

In the previous section, the Timber Company of Mendocino has established its organizational boundaries as the 20,000 hectares of trees that it wholly owns. Since the Registry only requires verain pools of direct carbon stocks and emissions to be reported, TCM would be required to identify only the following pools for its operational boundaries of 20,000 hectares of trees: 1) tree biomass 2) standing dead biomass 3) lying dead wood. TCM may also choose to identify optional direct pools within its 20,000 acre acres, such as soil or any wood products produced from the entity.

Example C: Operational Boundaries Example

Conservation Group (CG) wholly owns 10,000 hectares of land that has some tree cover and plans to restore the forest to the area over time. To report its entity C stocks and biological emissions to the Registry, CG must identify the carbon pools for its operational boundaries as part of the process. While its land area does not have carbon in its direct required pools for standing dead biomass of lying dead wood, CG will still identify these two pools as well as tree biomass as its direct required pools – as these categories may contain carbon in the future. In the years that these pools do not contain carbon, CG will report zero for these categories.

V. Characterizing and Establishing a Baseline

Optional, though strongly encouraged

A forest entity's biological baseline is reflected as a projection over time. Unlike other sectors that may have a relatively constant baseline and can therefore choose their baseline in a particular year, a forest entity's biological baseline is typically not static and can fluctuate as part of a normal business or natural cycle.

Once you have identified your geographic and organizational boundaries, you must decide if you wish to establish a baseline for your entity's biological C stocks and emissions. A biological baseline for a forest entity is a long-term projection of an entity's forest carbon stocks over one hundred years that is based on the entity's forecasted management practices and goals. Thus, it incorporates qualitative and quantitative components. The qualitative component is the description of practices over time, while the quantitative component is the actual estimate of carbon stocks that are based on the projected practices.

There are a series of steps to establish an entity baseline. First, you must qualitatively characterize your entity baseline, as described in this Part. Once this is done, you must quantify your entity's existing forest carbon stocks from the required pools, as described in Part VI. Finally, you must forecast your entity baseline carbon stocks over time, pursuant to your characterization and quantification of carbon stocks. This is done through the use of models, also explained further in Part VI.

While it is optional to establish an entity baseline, the Registry *strongly encourages* you to do so, particularly if you are undertaking a forest project. If you choose not to establish an entity baseline, you will simply report your entity's forest carbon stocks on an annual basis, using the quantification guidance in Part VI.

A. Purpose of Establishing A Biological Entity Baseline

The benefits of establishing a baseline for your entity

The purpose of establishing a biological baseline for an entity is similar to a non-biological baseline in the sense that it serves as a reference for comparison over time. It provides a basis for comparing your entity's annual reported carbon stocks against those anticipated due to your typical business cycle or intended practices. If you are implementing a forest project, the entity baseline can add significant additional credibility to your project's reported GHG reductions, as it can demonstrate that your entity is not causing activity-shifting leakage[8] within your entity boundaries that would undermine your project or its reported GHG reductions. While the sale or transfer of project GHG reductions is beyond the scope of the Registry, it is important to note that such credibility will be important if your project's GHG reductions are transferred or sold to another party.

[8] Activity-shifting leakage is the displacement of activities from inside an entity's physical boundaries to locations outside of the entity's boundaries, as a direct result of actions/practices within the entity boundaries.

B. Biological Entity Baseline Qualitative Characterization

Characterize your biological entity baseline according to planned forest management or practices and overall objectives

As a first step to establish your entity biological baseline, you must characterize your baseline. This characterization is a qualitative description of the forest practices or management scenarios that are intended to occur over a 100-year projection timeframe. It should also be based on the overall objectives for the entity forest area. This characterization must be substantiated with documentation that will ultimately be reviewed during the verification process.

Similar to the establishment of a non-biological baseline, your biological baseline year may date back as early as 1990. However, all data required by this protocol must be provided, reported and verified for each consecutive year of reporting to the Registry.

The biological entity baseline characterization should therefore be comprised of:

1) A written description of the overall long-term objectives for the forest entity area.
2) A written description of the practices/management that will take place in the entity forest area over the 100-year period. This should include the timing, extent and quality of any harvest or tree removals, planting and/or restoration within the forest entity area.
3) Documentation that supports 1) and 2), as written above. The following are minimal components to include in the documentation to support the entity baseline characterization:

    - Management Objectives.
    - Land Conservation Practice Needs.
    - Fish and Wildlife Improvement Needs.
    - Fire Protection Needs.
    - Insect and Disease Problems.

If your entity is managed for commercial timber, your characterization must be supported by any existing long-term management plan. Examples of such plans in California include Sustained Yield Plans (SYPs), Option A Projections, Non-industrial Timber Management Plans (NTMPs), or Programmatic Timber Environmental Impact Reports (PTEIRs). Others include California Forest Improvement Plans (CFIP), or Coordinated Resource Management Plans (CRMPs).

Example D: Baseline Qualitative Characterization Example

The following example is a fictitious landowner. The description is intended to provide a flavor of the qualitative characterization that would accompany an Entity Report and to set the stage for examples of protocol concepts used throughout the Entity Protocols and the Forest Project Protocols. An actual baseline qualitative characterization would cover each of the items listed in the text above in great depth. The example continues throughout this document and into the Registry's Forest Project Protocol.

The Timber Company of Mendocino (TCM) has decided that they will manage the forest with a mixture of silviculture regimes that lead to a mosaic of forest conditions over time and space. The forest was cleared around 1900. Subsequent harvest entries occurred after

1965 with the focus on removing the largest second growth trees. The current general forest condition is dominated with well-stocked 40-year old trees with scattered older trees dispersed through the forest, as well as in isolated stands.

The goal is to reduce the density and increase the size of the trees in the forest. The emphasis in harvesting will be to increase the spacing between trees to provide an aesthetically appealing forest. Small openings will be created through group selections to add a complexity of habitat types and provide for regeneration. A portion of the forest (120 hectares) is adjacent to State Park. This area, as well as the watercourse buffers, will be managed with harvesting techniques that maintain a high degree of canopy cover. This area is to be considered as a Carbon Project and is further described in the Forest Project Protocol document.

C. Updating Your Baseline

When you must update your baseline

If you choose to establish an Entity biological baseline, you will need to consider the circumstances for updating your baseline characterization. You must adjust your biological baseline if any of the following actions, or combination of actions, occur and change your annually reported total C stocks by +/- 10%. The actions that will trigger you to update your biological baseline are as follows:

1) Structural Changes in Your Organization:

   - Mergers and acquisitions
   - Divestitures

2) Shifting of Emissions Sources:

   - A shift in the location of an emission source (into or out of the State of California, depending on your geographic boundaries)

   - Please note, for purposes of leakage you may be asked by the verifier to provide an explanation for shifting a biological emissions source outside of the selected geographic reporting boundaries.

3) Catastrophic Event

   - You must update your baseline if a catastrophic event, a natural fire, disease, or pest infestation changes your total carbon stocks

4) Implementation of improved carbon measurement technique

   - Your biological baseline must be adjusted if there are fundamental changes in your measurement methods that impact your entity's carbon stocks.

5) Inaccurate growth assumptions

- Projections of carbon stocks in the entity baseline are based on growth models. Overestimates of growth may be due to an overstatement of site quality, a need to calibrate the model to local conditions, or to an inappropriate application of the growth model.

6) Changes in management practices

- You must update your baseline if changes are necessary to fulfill long-term goals stated pursuant to the baseline characterization, so long as such changes occur at a frequency greater than 25 years

Please note that your baseline need only be adjusted whenever you estimate that the cumulative effect of the changes above is greater than 10%.

VI. Quantifying Your Forest Entity's Biological Carbon Stocks, Biological Emissions and Baseline

A. Introduction

This Part provides guidance to quantify your forest entity's biological carbon stocks. As a forest entity, you are required to follow this section whether or not you choose to establish a biological entity baseline, as the information from this Part is necessary for reporting not only your entity biological baseline, but your required annual forest carbon stock reporting as well.

If you have chosen to report a biological baseline, this Part will enable you to quantify your entity's baseline in carbon terms, pursuant to the descriptive baseline characterization you developed in the previous section. If you have elected not to report a baseline, you will still need to quantify your carbon stocks pursuant to this Part to report annually. This section reflects a stock change accounting approach. Any annual reported carbon stocks that reflect a decrease compared to the previous year will be calculated as your entity's biological emissions. Any reported increase in carbon stocks compared to the previous year will support a GHG reduction if you are implementing a project pursuant to the Registry's FPP.

The first section of this Part explains the essential components to complete your forest entity carbon inventory. It then provides guidance regarding the quantification of all your required and optional direct carbon pools. Please refer to the Worksheet for Summarizing Carbon Pools and Calculating Total Carbon Weight in Step 9 of this part, which should be used as you quantify each of these pools. Following the guidance for quantification of each pool, additional instruction is provided on the use of models, as well as the Registry's ongoing monitoring requirements, which are essential for any baseline projection and annual carbon stock reporting. Finally, the last section provides an explanation regarding how your entity's GHG reductions and biological CO_2 emissions are calculated.

B. Provide Background Information on Forest Area

To begin the quantification process, you must supply a general physical description of your forest entity area as these physical properties influence your forest carbon stocks and any biological emissions. This information should help inform the initial design of your forest inventory, as well as your estimations of forest carbon stock and emissions. This information will be reviewed in the verification process.

When you are ready to quantify your forest carbon stocks, you should refer to the Forest Entity Summary Worksheet in Annex B to provide the following information:

- Forest entity boundaries
- Acreage of entity forest area
- Latitude/longitude or Public Land Survey
- Existing land cover and land use
- Topography
- Forest Vegetation
- Site Classes
- Wildlife Habitat Relationship (WHR) Classes
- Watercourses in area
- Land pressures and climate regime

This information must also be presented in a map during verification.

C. Summary of Carbon Pools to Quantify in Your Entity Forest Area

The measurements to determine carbon stocks and CO_2 emissions for your project are broadly grouped into the following categories:

1. Above-ground living biomass
2. Below-ground living biomass
3. Dead biomass
4. Soil

Please note: The value of tree removals for biomass energy is not considered in the FSP. Rather, it will be considered in the Registry's industry-specific protocol for the power sector.

While reporting entity-wide carbon values may include the measurement and reporting of all the categories listed above, only verain ones are required and verified by the Registry. The main purpose of classifying categories as required is to ensure that any significant declining carbon pools are accounted for. The Registry also provides flexible options for counting steady or increasing carbon pools through the non-required carbon pools. Optional categories will not be verified by the Registry.

Some of these values will be determined through direct sampling. Table A summarizes the categories with their associated pools and identifies which pools will be required versus those that are optional entity reporting. It also shows how the value for the pool is determined.

Table A: Registry requirements of carbon pool categories and determination of value for pool

Category	Carbon Pool	Step	Required?	Determination of Value
Living biomass	Above-ground Tree Biomass	2	Yes	Sampled in Entity
	Below-ground Tree Biomass	2	Yes	Calculated based on aboveground biomass
	Shrubs and Herbaceous Understory	6	No	Sampled in Entity
On-site Dead biomass	Standing Dead Biomass	3	Yes	Sampled in Entity
	Lying Dead Wood	4	Yes	Sampled in Entity
	Litter and Duff	7	No	Sampled in Entity
Soil	Soil	8	No	Sampled in Entity
Off-site dead biomass	Wood Products	5	No	Decay calculation from volume of harvested wood

D. About Forest Inventories

To develop estimates of carbon stocks in the carbon pools identified in Table A, a forest inventory must first be conducted. Standard forest inventories require the establishment of sample plots and provide inventory estimates in terms of cubic or board foot volume. These measurements are typically based on the trunk, or bole diameter, form, and height of the

tree. However, the current equations provided by the Registry facilitate biomass and carbon mass estimations using the bole diameter alone for live trees and sound standing dead trees. Estimates of belowground living biomass are calculated based on aboveground estimates. Estimates of lying dead and standing dead tree (for non-sound trees) biomass can be computed in terms of cubic volume and subsequently converted to biomass/carbon mass estimates. Verifiers may grant approval to use different allometric equations than those provided by the Registry.

For entities that have reportable carbon values, the Registry requires a complete inventory for the estimates of carbon stocks to be verified. An example of an entity with little or no carbon values is the early phases of reforestation. For all other cases, a complete inventory must be executed before you submit your annual carbon stock estimate for reporting in the Registry and must be maintained throughout the time you report to the Registry. A complete inventory includes an estimate of carbon stocks from the required pools within the entity that meets or exceeds the minimum confidence standard described in this section.

A complete inventory will include:

- A sampling methodology
- A set of inventory plots
- A description of the stratification system (if used)
- Analytical methods to translate field measurements into carbon mass and/or biomass estimates.

The plot data used for deriving the estimates must have been collected within the last 12 years. It is expected that forest entities may have different approaches to conducting an inventory, that is, some may implement a rolling inventory while others may undertake more periodic comprehensive inventories. Either approach is acceptable so long as an inventory of the entire entity area (its required carbon pools and corresponding sample plots) is completed within twelve-year intervals.

The steps that follow provide more detailed guidance to establish a complete inventory and estimate carbon stocks. The required carbon pools are addressed in Steps 2 through 4 and optional pools are listed in Steps 5 through 8. Please use the worksheet in Section E to organize your results.

Example E: Quantification Example (Part I – Introduction)

The following example is intended to demonstrate how a carbon estimate is derived for a forest entity. Both the data shown and any assumed sampling methodologies are hypothetical. Only required reporting carbon pools (tree biomass, standing dead, and lying dead biomass) are shown in the example. The example is intended to specifically demonstrate the following:

- The use of allometric equations to determine biomass from diameter measurements.
- How individual measurements are expanded to an area estimate.
- A methodology for calculating biomass in standing dead biomass and lying dead biomass using hypothetical coefficients to convert volume estimates to biomass estimates.
- How biomass estimates are converted to carbon ton estimates.
- How plots are summed to compute an average carbon estimate for each stratum and overall for a hypothetical entity area.
- How confidence is determined for the carbon ton estimate and how confidence deductions are applied.

The scenario for the example is The Timber Company of Mendocino (TCM) with 20,000 hectares of forestland in the redwood region.

Step 1 – Develop Inventory Methodology and Sample Plots
Required

As your initial inventory step, you must develop and describe a methodology to sample for biomass or volume in the required carbon pools. Your sampling methodology should enable you to quantify the carbon pools within your established boundaries and usually involves extrapolating the forest biomass based on sample plots. Annex E contains recommended references for developing sampling methodologies. Sampling methodologies for any optional carbon pools, where a determination of the biomass or volume is derived from sampling, is also required for those pools you wish to include in your entity.

Your sampling methodology and measurement standards should be consistent throughout the time you report to the Registry. All sampling methodologies and measurement standards must be statistically sound and reviewed by verifiers. While stratification is not a requirement, it should be noted that it does have the potential to simplify verification and possibly lower the costs of verification for reporters. Regardless of whether a stratification system is employed in your inventory, all sample plots shall be monumented for auditing and monitoring purposes. While plots need not be permanent, reporters must monument plots in a way that allows them to be located and revisited for a period of 12 years. If, at the time you first report and verify data, your inventory plots are not monumented in this fashion, you will have until the second verification (i.e. 6 years) to install appropriately monumented plots. Plot centers should be referenced on maps, preferably from GPS coordinates. The methodologies utilized shall be documented and made available for verification and public review. Annex E provides a list of references of possible sampling methodologies.

The design of your sampling methodology and measurement standards must include the requirements stated below. Table 1.1 presents these requirements by carbon pool:

Table 1.1 Minimum Required Sampling Criteria

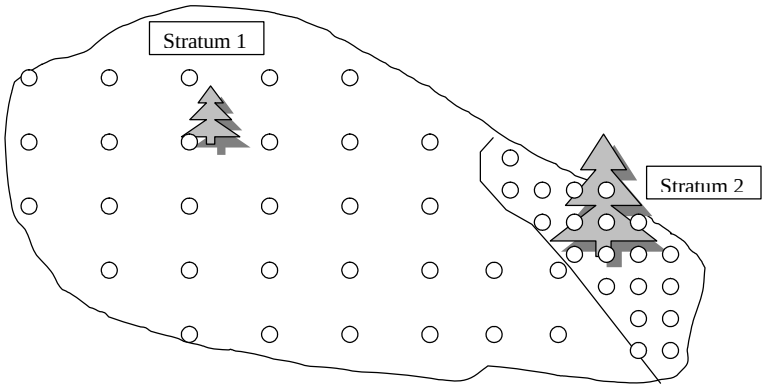
Carbon Pool	Required Pool?	Name of Requirement	Description of Requirement
Above-ground Tree Biomass	Yes	Diameter (breast height) Measurements	Stated minimum diameter in methodology not to be greater than 3".
		Measurement Tools	Description of tools used for height measurement, diameter measurement, and plot measurement.
		Measurement Standards	The methodology shall include a set of standards for height and diameter measurements.
		Plot Layout	A description of plot layout.
		Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be included in the sampling design.
		Allometric Equation used for Estimating Biomass	The methodology will include a description of the allometric equation used to estimate the whole tree biomass (bole, branches, leaves, and roots) from bole diameter measurements. Any diversion from the provided equation will need to be approved by the Registry.
Below-ground Living Biomass	Yes	Plot-level Allometric Equation used for Estimating Biomass	Apply model (Cairns et al. 1997) to estimate below-ground biomass density. Model equation is based on above-ground biomass density in tons per hectare. Use of alternative equations will need to be approved by the Registry prior to use.
Herbaceous Understory	No	Sampling Methodology	The Registry recommends the sampling methodology prepared by Winrock Corporation for the California Energy Commission in cooperation with the California Department of Forestry and Fire protection (CDF). This methodology is referenced in Annex C. Alternative methodologies will need to be reviewed and approved by the Registry.
Standing Dead Biomass	Yes	Diameter (breast height) and top Diameter Measurements	Stated minimum breast height diameter in methodology not to be greater than 3". Description of how top diameter is derived.
		Measurement Tools	Description of tools used for height measurement, diameter measurement, and plot measurement.
		Measurement Standards	The methodology shall include a set of standards for height and diameter measurements.
		Plot Layout	A description of plot layout (May be the same layout for Tree Biomass).
		Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
Litter and Duff	No	Sampling Methodology	The Registry recommends the litter and duff methodology prepared by Winrock Corporation for the California Energy Commission in cooperation with the California Department of Forestry and Fire protection (CDF). This methodology is referenced in Annex C. Alternative methodologies will need to be reviewed and approved by the Registry.
Lying Dead Biomass	Yes	Diameter	Stated minimum average diameter in methodology not to be greater than 6" for pieces of dead wood at least 10' in length. If the average diameter is greater than 16", the minimum length for reporting not to be greater than 6'. Anything not meeting the measurement criteria for lying dead wood will be considered litter, an optional category.
		Measurement Tools	Description of tools used for length measurement, diameter measurement, and plot measurement.
		Measurement Standards	The methodology shall include a set of standards for height and length measurements.
		Plot Layout	A description of plot layout (May be the same as the layout for Tree Biomass).
		Merchantability of Trees	The methodology shall include all trees regardless of current merchantability to be including in the sampling design.
		Density by Decay Class	Description of methodology used to derive density estimates for each species (group) by density class

Example F: Quantification Example (Part II – Stratification and Plots)

The forest entity has many different vegetation types as the result of harvesting history, aspect, site class, and past management goals. The entity area has been stratified using vegetation characteristics. A total of 20 different vegetation strata have been identified for the entity.

The example will demonstrate the measurement equations on one plot in a hypothetical Stratum 1. The example will also highlight two of the vegetation strata for demonstration purposes. Stratum 1 is 100 hectares. It is a young growth forest that has been selectively harvested over the past 40 years. Stratum 2 is 20 hectares. It was initially harvested in 1900 and no harvesting has occurred since, hence it includes larger second growth trees. The other vegetation strata on the remaining 19,880 hectares vary in terms of species, size, and/or density.

The diagram below portrays the scenario. Plots have been laid out in a grid in each of the two strata. Stratum 1 has 30 plots, stratum 2 has 20 plots.



The protocols require estimates of carbon tons be derived for trees (above- and below-ground living biomass), standing dead biomass, and lying dead biomass. The methodology in this hypothetical example will obtain measurements for each of these carbon pools at each point identified in the drawing above.

Step 2 - Estimate Carbon in Live Trees from Sample Plots
Required

Tree biomass estimates are required for all entity reporting. You are responsible for determining appropriate methodologies for sampling to determine tree biomass. These estimates should be computed on a per hectare basis. The estimate of tree biomass will be combined with the estimates of standing dead biomass and lying dead biomass for determination of a mean estimate of the required pools derived from sampling, along with the a statistical summary that describes the statistical confidence of the estimate.

The following equations are provided for common California species for estimating tree biomass (kilograms per tree) from diameter (DBH) measurements.* This list does not contain all species that you may encounter in your entity. The Registry will accept the application of equations for species that are close surrogates in terms of tree form until a more comprehensive list can be developed. Diameter measurements should be in centimeters.

Table 2.1 Equations for Tree Species Biomass Estimates

Species	Biomass (kg) Equation	Limitations
Coast Redwood	Exp(-2.0336 + 2.2592 * ln DBH)	Max DBH = 250 cm
Giant Sequoia		
Incense Cedar		
Douglas-fir	Exp(-2.2304 + 2.4435 * ln DBH)	Max DBH = 210 cm
Pinus sp.	Exp(-2.5356 + 2.4349 * ln DBH)	Max DBH = 180 cm
Abies sp.	Exp(-2.5384 + 2.4814 * ln DBH)	Max DBH = 230 cm
Quercus sp.	Exp(-2.0127 + 2.4342 * ln DBH)	Max DBH = 73 cm
Tanoak	Exp(-2.4800 + 2.4835 * ln DBH)	Max DBH = 56 cm
*Equations from Draft Sampling Methodology by Winrock, International. The reference is in Annex C.		

The derived estimate of biomass shall be multiplied by 0.5 to calculate the mass(kg) in carbon. This product shall be multiplied by 0.001 to convert the mass to metric carbon tons.

Because of the difficulties associated with measuring below ground carbon component of trees, the Registry allows for the estimation of this component of tree carbon through the use of a regression equation (Cairns et al., 1997). This equation provides a practical and cost-effective approach that estimates below ground biomass based on the sampling based calculation of above ground biomass only:

BBD = exp(-0.7747 + 0.8836 x lnABD)

Where BBD = belowground biomass density in tons per hectare
ABD = aboveground biomass density in tons per hectare

It is important to note that this equation must be applied at the plot level, after estimates of aboveground biomass have been calculated as described above.

Example G: Quantification Example (Part III – Tree Biomass)

The chart below displays summary data for tree biomass for the first plot in Strata 1.

Tree Biomass								
1	2	3	4	5	6	7	8	9
Plot	Tree Number	Species	DBH (cm)	Total Height (mt)	Status	Biomass (kg)	Weight (Expansion per Hectare)	Total Biomass per Hectare
1	1	Redwood	65	32	L	1,631	21	33,845
1	2	Douglas-fir	65	29	L	2,892	21	60,000
1	3	Tanoak	28	14	L	329	112	36,764
1	4	Redwood	68	30	L	1,806	19	34,243
1	5	Redwood	76	27	L	2,322	15	35,245
1	6	Douglas-fir	65	34	L	2,892	21	60,000
1	7	Tanoak	42	17	L	900	50	44,726
1	8	Tanoak	46	18	L	1,128	41	46,737
					Sum			351,561

The plot in this example was measured using a 30 square foot basal area factor prism. The plot number is entered in column 1. All 'in' trees are measured and input consecutively starting at North and proceeding clockwise. Each tree is numbered (column 2), the species documented (column 3), the DBH measurements entered as centimeters in column 4, and the total height entered as meters in column 5.

The status of the tree goes in column 6. The status codes are shown below.

Status Codes	Description
L	Live
D1	Dead, with large and small branches and twigs
D2	Dead, with large and small branches and no twigs
D3	Dead, with large branches only
D4	Dead, with no branches

Only live trees are input into the Tree Biomass worksheet. The biomass for each tree is determined (column 7) using the allometric equations provided in Step 2 in the Forest Project Protocols. The basal area factor and each tree's diameter (breast height) are used to determine the expansion factor, or weight, of each tree (column 8). The expansion factor is multiplied by each tree's biomass to portray the biomass estimate of each tree on a per hectare basis (column 9). Each tree's expanded biomass is summed to calculate the estimate total biomass in trees on plot 1. Plot 1's estimate of aboveground tree biomass in Strata 1 is calculated to be 351,561 kilograms per hectare. Based on this estimate, an estimate of below ground biomass on a per hectare basis can be calculated using the equation above. The estimate of belowground biomass is 81,844 kilograms per hectare. The combined estimate of biomass in Plot 1 is 433,405 kilograms.

Step 3 – Estimate Carbon in Standing Dead Biomass
Required

The carbon stocks in standing dead biomass, including stumps, must be included in the entity inventory report. While this category may not be an initial pool for forest entities in verain cases, it may become one over time. Therefore, it must be considered in the monitoring process and any entity projections of entity stocks. References for developing sampling methodologies, which are listed in Annex E, include Brown (1974), Harmon and Sexton (1996), and Brown et. al (2004).

The sampling methodology and protocols for deriving biomass estimates will be developed as part of an overall sampling strategy (discussed in Step 1). The estimate of standing dead biomass for highly decayed trees (broken tops, missing branches, etc.), must be calculated first volumetrically and subsequently converted to biomass and carbon tons. Sound dead trees can be computed using the equations provided for live trees in Step 2. The equations used in Step 2 provide an estimate of biomass in kilograms. The estimate must be converted to metric carbon tons by multiplying the result by .001

For those trees where volume is computed, the volume will need to be converted to biomass density by applying conversion factors based on a sub-sample of material that represents the species groups and decomposition classes. The methodology developed for both lying dead wood and standing dead biomass must include a description of the calculation techniques used to determine biomass density by decomposition classes and species (groups). The estimate of biomass density must be computed in terms of metric carbon tons on a per hectare basis. A description of a methodology to generate the density factors can be found in the Brown et. Al (2004) document mentioned above.

Example H: Quantification Example (Part IV – Standing Dead Biomass)

Standing dead biomass (snags) is measured on every plot. The chart below displays summary data for standing dead biomass for the first plot in Strata 1.

Strata 1											
Standing Dead Biomass											
1	2	3	4	5	6	7	8	9	10	11	12
Plot	Tree Number	Species	DBH (cm)	Top Diameter (cm) (For Status Code D4)	Total Height (mt)	Status	Density	Volume (cubic meters) for Status Code D4 only	Biomass (kg)	Weight (per Hectare)	Total Biomass per Hectare
1	1	Douglas-fir	30	0	20	D1	Sound	na	284.4	97.4	27,699
1	2	Redwood	61	46	20	D4	Intermediate	5.60	1008.0	23.6	23,745
								Sum			51,444

The entries in columns 1 through 4 are the same as the entries described for the tree biomass. Column 5 allows the input of a top diameter for dead trees with the status code 'D4'. The status codes are the same as those used for trees in the tree example. The status code D4 is for trees that generally have broken tops. The volume of these trees must first be determined before converting to biomass. Biomass for all other dead trees is determined using the same allometric equations used for the live trees. Total height for all dead trees is entered in column 6. The status code is entered in column 7 for each tree.

The density of the dead tree is entered in column 8. The density entry is used to determine biomass for dead trees with a 'D4' status code. The coefficients used to determine biomass are developed by sampling the density of the species in the forest in the various classes of decomposition. The process is described in the 'Methods for Measuring and Monitoring Forestry Carbon Projects in California' by Winrock International. The table below contains hypothetical coefficients used for determining biomass for both dead trees (standing dead biomass) and down logs (lying dead biomass).

Density Subsamples (kg/cubic meter)			
Species	Sound	Intermediate	Rotten
Redwood	360	180	60
Douglas-fir	400	210	50
Tanoak	480	235	40

Volume is calculated (column 9) for dead trees with 'D4' status codes and multiplied by the appropriate density coefficient to determine the biomass estimate in column 10. The biomass for dead trees with status codes D1, D2, and D3 is calculated the same way as live trees, using the allometric equations provided in Step 2 in the Forest Project Protocols and input into column 10. The expansion factor, or weight (column 11), of each tree is determined using the same techniques used for live trees and is described in the Tree Biomass section above. The weight of each dead tree is multiplied by its biomass estimate to portray the estimate on a per hectare basis (column 12). This is summed to determine the total biomass in standing dead biomass on Plot 1.

Step 4– Estimate Carbon of Lying Dead Wood

Required

The carbon content of lying dead wood must also be estimated in all entity inventories. As with standing dead wood, this category may not be present initially. However, it may become one over time and should therefore be considered in the monitoring process and any projections of entity carbon stocks. References for developing sampling methodologies are located in Annex E and include Brown (1974), Harmon and Sexton (1996), and Brown et. al (2004).

Field measurements of lying dead wood within the sample area enable calculation of volume to be easily computed. The computed volume will need to be converted to biomass density by applying conversion factors based on a sub-sample of material that represents the species groups and decomposition classes. The methodology developed for lying dead wood must include a description of the calculation techniques used to determine biomass density by decomposition classes and species (groups). The estimate of biomass density will need to be computed in terms of carbon tons on a per hectare basis. The carbon tons estimate is inserted into the worksheet in Step 9. A description of a methodology to generate the density factors can be found in Brown S. et al (2004) that is mentioned above.

The estimate of carbon tons for the lying dead wood pool and the standing dead biomass pool are summed with the tree pool for each sampled plot. This will provide the basis for determining the overall carbon ton estimate and descriptive statistics for the required pools. The overall carbon ton (per hectare) estimate of the required pools and the descriptive statistics are input into Worksheet in Step 9.

Example I: Quantification Example (Part V – Lying Dead Wood)

Lying dead wood is sampled on every plot. The chart below displays summary data for lying dead biomass for the first plot in Strata 1.

Strata 1										
Lying Dead Wood										
1	2	3	4	5	6	7	8	9	10	11
Plot	Log Number	Species	Large end Diameter	Small end Diameter	Total Length on plot (mt)	Density	Volume (cubic meters)	Biomass (kg)	Weight (per Hectare)	Total Biomass per Hectare
1	1	Tanoak	30	15	3.6	Rotten	0.6	24.0	25	600
1	2	Redwood	109	96	2.3	Sound	1.9	684.0	25	17,100
							Sum			17,700

The sampling method used in this example is a fixed area plot. The area sampled is a 1/25th hectare plot. The entries in the columns are similar to those already discussed for trees and standing dead trees. The volume in lying dead wood is calculated first and subsequently converted to biomass using the coefficients developed from the density subsamples.

The sum of the per hectare biomass estimates from the tree, standing dead and lying dead biomass are summed to determine the combined biomass estimate on Plot 1. The result of summing this example is shown below.

Plot 1		
Carbon Pool	**Biomass Sum per Hectare (kg)**	**Carbon Metric Tons per Hectare**
Trees	433,405	217
Standing Dead	51,444	26
Lying Dead	17,700	9
Total Biomass	420,705	252

The biomass sums are multiplied by 5 to convert to carbon biomass and subsequently by 0.001 to convert to metric carbon tons, as described in Step 2 in the forest project protocols. This process is completed for all plots in all vegetation strata. The sample results from Plot 1 indicate that there is 252 tons of carbon per hectare.

The biomass sums are multiplied by .5 to convert to carbon biomass and subsequently by 0.001 to convert to metric carbon tons, as described in Step 2 in the forest project protocol. This process is completed for all plots in all vegetation strata. The sample results from Plot 1 indicate that there is 210 carbon tons per hectare.

Optional Pools

The carbon pools described in Steps 5, 6, and 7 are not required by the Registry and will, therefore, not be verified. However, you may wish to report these carbon pool values in your annual Registry report and maintain your own accounting records and verification documents. The Registry may verify these pools in the future as the policies, science, and/or efficient measurement strategies are developed.

Step 5 - Estimate carbon in wood products

Optional

The wood product pool is an optional pool for all forest entity reporting. This pool applies only to entities that anticipate the removal of trees for conversion to a wood product. The recording of the wood products pool by the entity developer does not imply ownership. It does establish a record of a carbon estimate that persists in wood products and is depleted over time through decay. Ownership of the carbon associated with wood products is considered a matter beyond the scope of the Registry.

The accounting of wood products should include only those trees harvested within your entity boundaries. Trees harvested outside of your forest entity's physical boundaries shall not be counted as part of your wood product pool. Additionally if your entity includes a manufacturing facility, the non-biological emissions of wood harvesting and processing must be recorded as part of entity emissions under the general reporting protocols. Furthermore, if you have created a project pursuant to the Registry's Forest Sector Protocols, wood harvesting and processing must be flagged as upstream and downstream effects associated with the project activity. If your entity does not include a manufacturing facility, you must provide a good faith estimate of the non-biological emissions associated with the manufacturing of the wood products carbon that you are reporting.

A harvest that leads to the production of wood products within your entity must occur for the wood products pool to have value. The carbon from harvested trees is transferred to the wood products pool in the year that it was harvested. The timing of this is important to keep in mind for reporting clarity and proper accounting. This initial carbon value is then reported with each subsequent annual report at a declining scale to account for the product's decay until the value has been discounted to zero. Each year a harvest occurs, the amount harvested is added and then discounted at the appropriate decay rate as shown in the wood products worksheet below.

Process 1. Determine amount of carbon harvested and transferred to Wood Products Pool

This process applies to entities that have removed forest stocks for conversion to wood products in the reporting year. If you have no removals reported in the reporting year, you will go to process 3 to update removals from previous years. Your annual estimate for your wood products pool must be based on the current or most recent harvest volume reported to the Board of Equalization (BOE)[9]. The BOE reports will include a summary of harvested volume (board feet or cubic feet) by species delivered to the point of sale. This volume is multiplied by the pounds per thousand board feet (or cubic foot) values for each species shown in Table 5.1 below. An additional reference can be found in "Forestry Handbook,

[9] In states outside of California, harvest volume should be derived from the functional equivalent of California's Board of Equilization.

Second Edition, Wegner" (Table 4, page 582). This will enable you to obtain the total pounds of wood by species. Sum the weights for each species to get a total weight for all harvested wood. Multiply this total value by 0.5 pounds of carbon/ pound of wood to compute the total carbon weight, and then convert to tons of carbon (1 metric ton = 240 pounds). This value goes in Box 1 in the Worksheet below.

Table 5.1 Tree Species Weights @ 12 % Moisture Content

Species	Specific Gvty. MC 12%	Wt. / CuFt MC 12%	Wt./ MBF MC 12%
Alder, Red	0.41	28 lbs.	2330 lbs.
Aspen	0.38	26 lbs.	2170 lbs.
Cottonwood	0.35	24 lbs.	2000 lbs.
Maple	0.47	33 lbs.	2750 lbs.
Oak, Red	0.63	44 lbs.	3670 lbs.
Oak, White	0.68	48 lbs.	3920 lbs.
Walnut, Black	0.55	38 lbs.	3170 lbs.
Cedar, West.Red	0.32	23 lbs.	1320 lbs.
Cedar, Port Orford	0.43	29 lbs.	2420 lbs.
Cedar, Incense	0.37	---	---
Douglas fir	0.48	34 lbs.	2830 lbs.
Fir, White	0.39	27 lbs.	2250 lbs.
Hemlock, W.	0.45	28 lbs.	3000 lbs.
Pine, Lodgepole	0.41	28 lbs.	2330 lbs.
Pine, Ponderosa	0.40	28 lbs.	2330 lbs.
Pine, Sugar	0.36	25 lbs.	2080 lbs.
Pine, Western White	0.35	27 lbs.	2250 lbs.
Redwood, O.G.	0.40	28 lbs.	2330 lbs.
Spruce, Sitka	0.40	28 lbs.	2330 lbs.

Process 2. Accounting for mill inefficiencies.

The conversion of logs to wood products has been estimated to be approximately 60% efficient. That is, approximately 60% of the delivered log volume is converted into wood product volume. The remainder is considered to be immediately decayed. Therefore, the worksheet below includes the weight deduction for mill efficiency. The calculation for mill efficiency is accomplished by multiplying the carbon tons from Process 2 by 0.60.

Process 3. Allocation of wood products to product class.

This process applies to entities that have reported wood products values in previous years. In order to account for the decomposition of harvested wood over time, a decay rate is applied to wood products based on the half-life of carbon as determined by the wood product class. A single half-life (discount factor) must be used to calculate reportable wood products carbon value. The applicant can check with the mill where the logs are sold to determine the end use of the dimension lumber they sell (i.e., single family residence, furniture etc.), and placed in the appropriate row and column of the worksheet below. The annual reporting for a removal shall continue to the last year of the decay rate shown on the worksheet or if the entity developer decides to discontinue the entity reporting. In the latter instance, the pool will be deemed to no longer contain any value.

Wood Products Decay Worksheet

This worksheet includes two different calculations regarding wood products and wood product decay. The first calculation allocates your carbon weight by wood product class. The second calculation determines the amount of carbon remaining from the previous year's wood product carbon classes after deducting a portion of the weight to account for wood decay and adds this value to the current year's product class values. Decay factors are based on the work of Row & Phelps (1996) and Skog & Nicholson (1998). The process of calculating and recording a wood products carbon provided in these protocols is strongly recommended. However, there are other existing methodologies developed and available to account for carbon in wood products. Several of these are listed in Annex E

Table 5.2 Wood Products Decay Worksheet Part 1 (Current Year)

Carbon Tons in Current Year's Wood Products from Process 1 above.	(1)
Accounting for mill inefficiencies from Process 2.above. Multiply the value in Box 1 by 0.60.	(2)

Allocate the end use of the total wood products by assigning a percentage for each class (A – K). Multiply value from (2) by percentages assigned below in order to separate wood products carbon into product classes. Insert values into boxes (3 A-K) below each corresponding product class. Values in (3A-K) are carbon (tons) in each product class for the current year and are added to total entity carbon stores using a calculation below.

A	B	C	D	E	F	G	H	I	J	K
Single-family houses (pre-1980)	Single-family houses (post-1980)	Multifamily houses	Mobile homes	Residential maintenance and repair	Nonresidential construction	Manufacturing	Shipping	Furniture	Railroad ties	Other solid wood use
(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)	(X%)
(3A)	(3B)	(3C)	(3D)	(3E)	(3F)	(3G)	(3H)	(3I)	(3J)	(3K)

Table 5.2 Wood Products Decay Worksheet Part 2 (Previous Year(s))										
Insert previous year's wood product carbon pool values (e.g. values (4A-K for the year after a harvest event was first reported) in the appropriate boxes below.										
Single-family houses (pre-1980)	Single-family houses (post-1980)	Multifamily houses	Mobile homes	Residential maintenance and repair	Nonresidential construction	Manufacturing	Shipping	Furniture	Railroad ties	Other solid wood use
(4A)	(4B)	(4C)	(4D)	(4E)	(4F)	(4G)	(4H)	(4I)	(4J)	(4K)
Apply the following formula to each of the wood product pool classes (A-K) to determine the carbon stores remaining in each wood product carbon pool. Use the values of the variables shown in the boxes below to complete the calculation. Place results in boxes (5A-K). These are the remaining wood product carbon stores that should be reported as a portion of the total entity carbon stores. For each wood product class (A – K): Total wood products carbon (tons) = (X + Y) + [(X + Y) * ln(0.5) / Z]										
X = 3A Y = 4A Z = 80	X = 3B Y = 4B Z = 100	X = 3C Y = 4C Z = 70	X=3D Y=4D Z=20	X = 3E Y = 4E Z = 30	X = 3F Y = 4F Z = 67	X = 3G Y = 4G Z = 12	X = 3H Y = 4H Z = 6	X = 3I Y = 4I Z = 30	X = 3J Y = 4J Z = 30	X=3K Y=4K Z=30
(5A)	(5B)	(5C)	(5D)	(5E)	(5F)	(5G)	(5H)	(5I)	(5J)	(5K)
									Sum of wood product classes 5A – 5K:	

Step 6 – Estimate Carbon in Shrubs and Herbaceous Understory from Sample Plots

Optional

This pool is optional. Any methodology developed for measuring carbon in shrubs will need to be reviewed by verifiers. Appendix E provides a reference that can be used for predict aboveground biomass of plant species in early successional forests of the western Cascade Ranges.

The estimate will be computed in terms of carbon tons. The mean carbon ton estimate must meet the statistical standards described in Section E- Handling Unverainty. The mean estimate is input into the Herbaceous Understory Section in the worksheet in Step 9 on a per hectare basis.

Step 7 – Estimate of Carbon Tons in Litter and Duff
Optional

Litter is an optional pool. Litter is the dead plant material that can still be defined as leaves, grasses, and small branches. The largest material that can be considered litter is the minimum diameter stated in the methodology for lying dead wood. The duff layer is the organic material layer at the soil surface under the litter layer. The duff layer consists of dead plant materials that cannot be defined as leaves, grasses, and small branches.
The estimate will be computed in terms of carbon tons. The mean estimate is input into the Litter and Duff Section in the worksheet in Step 9 on a per hectare basis. The Registry recommends the litter and duff sampling methodology that is detailed in Brown et al. (2004).

Step 8 – Estimate Carbon in Soil
Optional

Soil Carbon is an optional category. However, your entity reporting should include a discussion of anticipated effects of your entity activities on soil carbon. As an option, you may still choose to account for this pool if you expect a significant increase in this category during the life of your entity. However, it is good to keep in mind that changes in total soil carbon are a challenge to measure over short timeframes as this pool changes slowly and is usually dependent on the rate of biomass input relative to soil decomposition. The sampling methodology and protocols for deriving carbon estimates in soil will be developed as part of an overall sampling strategy (discussed in Step 2). The Registry recommends the soil sampling methodology of Brown et al. (2004). This reference for this methodology can be found in Annex E.

The estimate will be computed in terms of carbon tons. The mean estimate is input into the Soil Section in the worksheet in Step 9 on a per hectare basis.

E. Minimum Confidence in Estimates

The Registry prefers all estimates of reported carbon pools, required or not, to have a high level of statistical confidence. Measurement standards are established by the Registry for the carbon ton estimate in the required pools derived from sampling. Confidence in the estimate of carbon tons from sampling can be measured statistically in terms of the size of the standard error relative to the estimate of the mean. This establishes the confidence limits and can be expressed as a percentage of the mean. Larger confidence intervals indicate that there is less confidence in the mean estimate than smaller confidence intervals. For all carbon pools reported to the Registry, the standard error must be within 20% of the estimate of the mean for the estimate to be accepted. The carbon ton estimate is input into the Tree Section in the worksheet in Step 9.

Example J: Quantification Example (Part VI – Summing Plots, Determining Sampling Error and Determining if the Estimate is Within Standards)

The table below shows the summary results for each plot in each of the two representative strata. It also shows the average carbon ton estimate on a per hectare basis and some descriptive statistics for the two strata.

Stratum 1					
Plot #	Carbon Tons per Hectare	Plot #	Carbon Tons per Hectare	Plot #	Carbon Tons per Hectare
1	252	11	75	21	245
2	300	12	235	22	235
3	350	13	215	23	250
4	225	14	265	24	265
5	165	15	145	25	270
6	140	16	195	26	315
7	135	17	205	27	330
8	380	18	305	28	310
9	275	19	165	29	295
10	125	20	160	30	205
Average Carbon Tons					234
Sampling Error (90% Confidence Level)					22
Confidence Interval as a Percent of the Mean (90%)					9.4%
Stratum 2					
Plot #	Carbon Tons per Hectare		Carbon Tons per Hectare	Plot #	Carbon Tons per Hectare
1	337	8	367	15	342
2	296	9	260	16	366
3	308	10	260	17	355
4	271	11	322	18	423
5	289	12	323	19	437
6	228	13	439	20	156
7	144	14	309		
Average Carbon Tons per Hectare					312
Sampling Error (90% Confidence Level)					31
Confidence Interval as a Percent of the Mean (90%)					10%

Step 9 – Summation of Carbon Pools

Table 9.1: Worksheet for Summarizing Carbon Pools and Calculating Total Carbon Weight

Carbon Pool	Required Pool?	Gross Carbon Tons per Hectare	Confidence Deduction	Adjusted Carbon Tons per Hectare	Adjusted Carbon Tons per Entity
Steps 2 – 4 Tree	Yes	From sampling results of trees, standing dead biomass, and lying dead biomass.	Does the estimate meet the standards described in Section E (Handling Unverainty)? Y/N	If the answer is yes, no deduction is applied. If the answer is no, the value is zero.	Enter Gross Carbon Tons per Hectare * Total Hectares or zero
Step 5 Wood Products	No	From Board of Equalization Reports and calculations explained in Step 5.	No deduction since it is not a sampling process	Estimate is on a per entity basis	Same as value at left
Step 6 Shrubs and Herbaceous Understory	No	From sampling results of shrubs and herbaceous understory.	Does the estimate meet the standards described in Section E (Handling Unverainty)? Y/N	If the answer is yes, no deduction is applied. If the answer is no, the value is zero.	Enter Gross Carbon Tons per Hectare * Total Hectares or zero
Step 7 Litter and Duff	No	From sampling results of litter and duff.	Does the estimate meet the standards described in Section E (Handling Unverainty)? Y/N	If the answer is yes, no deduction is applied. If the answer is no, the value is zero.	Enter Gross Carbon Tons per Hectare * Total Hectares or zero
Step 8 Soil	No	From sampling results of soil.	Does the estimate meet the standards described in Section E (Handling Unverainty)? Y/N	If the answer is yes, no deduction is applied. If the answer is no, the value is zero.	Enter Gross Carbon Tons per Hectare * Total Hectares or zero
				Sum of Adjusted Biomass from Optional Pools	
				Total Carbon Tons/Entity	

Example K: Quantification Example (Part VII – Summation of Carbon Pools)

Since only required pools were demonstrated in this example, there is only one record to complete.

Carbon Pool	Required Pool?	Gross Carbon Tons per Hectare	Confidence Deduction	Adjusted Carbon Tons per Hectare	Adjusted Carbon Tons per Project
Steps 2 – 4 Trees, Standing Dead Trees, and Lying Dead Wood	Yes	185	Inventory Estimate Meets Registry Standards	185	3,700,000
				Sum of Adjusted Biomass from Optional Pools	0
				Total Carbon Tons/Project	3,700,000

F. Use of models to estimate and forecast carbon stocks for entity baselines and annual reporting

The Registry uses and permits the use of verain empirical-based models to estimate the carbon stocks of the required and selected optional carbon pools within an entity's geographical area. They may also be used to forecast gains and/or losses in carbon stocks in your entity forest area over time. These forecasts are necessary to estimate and report your carbon in your entity's baseline projection, which is based on your carbon inventory and baseline qualitative characterization established in the preceding sections. Even if you have chosen not to report an entity biological baseline to the Registry, modeled projections may be useful to support your annually reported forest carbon stocks as a complement to required direct sampling.

G. About models and their eligibility for use in the Registry:

Empirical-based models are used for estimating existing values where direct sampling is not possible or cost-effective. They are also used to forecast the estimations derived from direct sampling into the future. Field measurements provide the basis for inferring value through the use of these models.

Models used for producing estimates of carbon values provide two basic functions. First, they determine values for existing tree volume and correlated carbon stocks. These include equations that infer tree biomass from diameter measurements.

Any equations provided in the preceding sections are pre-approved for use in the Registry. If forest entities would like to use equations that are different from those provided in this Protocol, such equations must be equivalent to or more accurate than those provided. This equivalency or greater accuracy must be demonstrated to the Verifier during the verification process. Also, the assumptions applied in the model must be transparent and made available to the Verifier.

The second function of models is the projected results of direct sampling through simulated forest management activity. These models, often referred to as growth

simulation models, may project information regarding tree growth and mortality over time – values that must ultimately be converted into carbon in an additional step. Other models may combine steps and estimate tree growth and mortality, as well as changes in other carbon pools and conversions to carbon, to create estimated projections of carbon stocks over time.

These models must either be pre-approved by the Registry or meet verain criteria to be eligible for use in the Registry. Models that have been accepted by the California Department of Fire and Forestry Protection (CDF) through the approval of a long-term management plan are automatically considered pre-approved by the Registry. Such models include, but are not limited to:

- CACTOS: California Conifer Timber Output Simulator
- CRYPTOS: California Conifer Timber Output Simulator
- FVS: Forest Vegetation Simulator
- SPS: Stand Projection System
- VFP: Visual Forester Professional
- FREIGHTS: Forest Resource Inventory, Growth, and Harvest Tracking System
- CRYPTOS Emulator

Models that have not been pre-approved by the Registry may also be used, but entities must demonstrate to the Verifier that such models meet the following criteria:

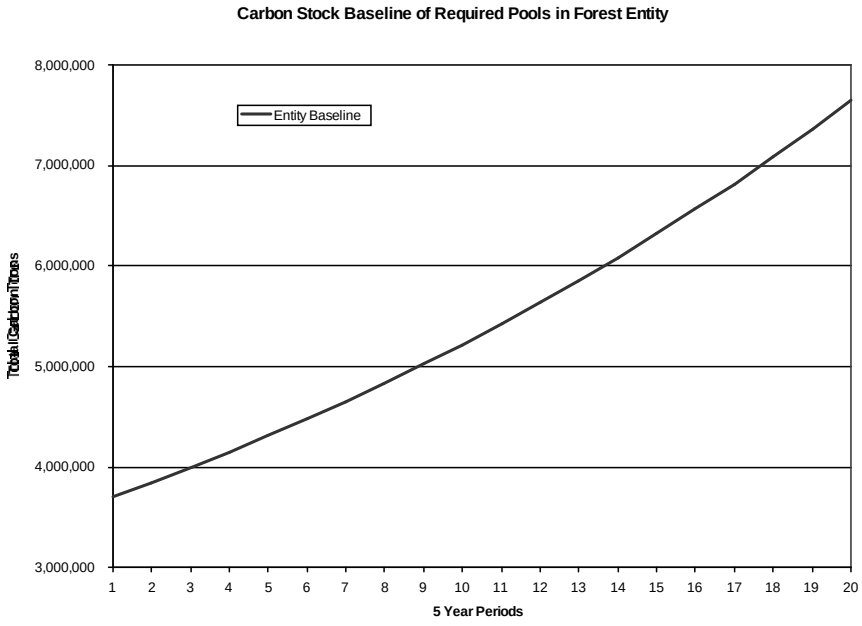
- They have been peer reviewed in a process that: 1) primarily involved reviewers with necessary technical expertise (e.g. modeling specialists and relevant fields of biology, forestry, ecology etc.) and 2) was open and rigorous
- They must be parameterized for the specific conditions of the entity land area
- Their use has been limited to the scope for which the model was developed and evaluated
- They must be clearly documented to include the scope of the model, assumptions, known limitations, embedded hypotheses, assessment of unverainties and sources for equations, data sets, factors or parameters, etc.
- They undergo a sensitivity analysis to assess model behavior for the range of parameters for which the model is applied
- They are periodically reviewed[10]

Example L: Quantification Example (Part VIII – Forecasting Carbon Stocks in Entity Baseline)

[10] S.P. Prisley and M.J. Mortimer. General guidelines for forest carbon accounting models: a synthesis of literature on evaluation of models for policy applications. (In Press.)

The total carbon stocks derived from sampling the required pools provides the basis for projections into the future using models described in the section above. The basis for the entity baseline is the sum of the carbon stocks deducted for unverainty.

The management goals and policies have been described in Section V (*Biological Entity Baseline Qualitative Characterization). The chart below displays a hypothetical projection of The Timber Company of Mendocino's carbon stocks for the entity as the management goals and policies are applied to it.*



H. Use of models to establish entity biological baseline and support annual carbon stock reporting

The use of simulation models is necessary for determining and reporting your entity biological baseline and supports your entity's annual reported carbon stocks. As mentioned earlier, if you choose to establish and report your baseline to the Registry, you must forecast your baseline over 100 years. You should describe and include a graph of your entity baseline (similar to Example L) in the Forest Entity Summary in Annex B.

Your entity baseline should be the product of your baseline characterization and complete carbon stock inventory accomplished in the preceding sections. This information should be incorporated into the simulation models so that you can create your entity baseline as a projection of your entity's carbon stocks over time. If your model has the ability to convert biomass to carbon, it should include all the required carbon pools. However, the carbon stocks of the wood products carbon pool should be

forecasted separately, as this information is required to be reported separately by the Registry.

Your baseline should be portrayed in a graph depicting time in the X-axis and carbon tons in the Y-axis. The graph should be supported with a written description that explains any changes in carbon stocks from one year to the next.

The projections from simulation models also support your annual reporting results. The Registry requires you to report your entity's forest carbon stocks and calculate any CO_2 emissions on an annual basis (see Section J for more information regarding the calculation of GHG emissions). If you are not conducting direct sampling of all of your plots on an annual basis, you may use your reported baseline or simulated projections to report your annual carbon stocks, so long as it is supported by your annual monitoring reports (see below) and any sampling that your entity has conducted for that year.

I. Monitor entity-wide forest area

As part of an ongoing assessment and reporting of your entity's carbon stocks, you are obligated to monitor your entity area. The purpose of the monitoring process is to assess your entity's carbon stocks and any changes therein and assess any occurrences of activity-shifting leakage if you are performing a forest project (for more information on activity-shifting leakage and projects, please see the Forest project Reporting Protocol). This information is captured and assessed through the following processes: 1) submission of annual monitoring reports by the project developer to the Registry and 2) third party verification of the entity over 6-year intervals, which is described in the Part VII.

Direct Sampling:

As mentioned in earlier sections, direct sampling of your entity's required carbon pools is required as part of the ongoing monitoring process. The use of projection models, discussed in the previous section, should be used as a complement to the direct sampling process. You may conduct direct sampling on a rolling basis (e.g. approximately 8 % annually) or on a periodic basis (e.g. 100% every 12 years), so long as all required carbon pools and their corresponding sample plots are sampled within twelve-year intervals, at least. *Please note that this direct sampling interval differs from the verification intervals.*

Your ongoing direct sampling should support the annual monitoring reports that you are required to submit to the Registry. The following information provides additional background regarding the required components of entity monitoring.

Annual Monitoring Report:

On an annual basis, a monitoring report must be submitted to the Registry. The purpose of this report is to report your annual estimated carbon stocks, attest that you are carrying out your projected practices, and discuss if your entity's carbon stocks are accumulating or decreasing in accordance with initial projections. Annex C is a template for the annual monitoring reports, the results of which will be entered into the Registry's online reporting tool, known as CARROT, and reviewed by the Registry.

Specifically, your annual monitoring report must include the following:

- *Carbon stock estimate:* Provide estimate of total carbon stocks in entity area for the year being reported, including anticipated or unanticipated changes in the stocks due to disturbances. Depending on your inventory methodology, these estimates may be based on direct sampling and/or modeled results.

- *Management plan:* If you established an entity baseline, you are required to submit an annual written assurance that the projected management activities are being implemented, as described in your entity baseline characterization.

- *Disturbances:* The written report should list any disturbances (tree removals, natural significant disturbances etc.) that have occurred, the date of the disturbance(s), the extent of the disturbance, including whether it is a natural significant disturbance, and if a baseline was established, whether the disturbance was originally anticipated in the entity baseline.

Ultimately, the information gathered through this monitoring process should support any estimates of carbon stocks and any GHG emissions reported to the Registry.

It is important to note that the annual monitoring reports will NOT be verified by your verifier. However, your verifier will review the information contained in the monitoring reports annually to check the information against public records and if an inconsistency is found you will be required to explain or address the issue with your verifier.

J. Changes in Forest Carbon Stocks and Calculating GHG Emissions

The Registry's forest carbon accounting is a stock change approach. Your annual reports of entity carbon stocks will reflect any entity-wide changes in your carbon stocks over time. Any decrease in carbon stocks between reporting years will be deemed CO_2 emissions.

For instance, if you report 10,000 tons of carbon for your forest entity in 2006 and report 8,000 tons of carbon the following year, 2,000 tons of carbon will be deemed as emissions. These 2,000 tons will be converted to a CO_2 estimate of 7,332 tons by multiplying the tons of carbon by 3.666.

Your entity's reported annual carbon stocks may also increase between reporting years. Increases in your total entity forest carbon stocks are not verified as GHG emissions reductions by the Registry unless you undertake an approved forest project pursuant to the Registry's Forest Project Protocol (FPP). If you are implementing a forest project, your reported entity information, which is required if you are doing a project, will provide significant credibility and support for any claimed GHG reductions at the project level. It will provide additional insurance to potential investors and the public that you are not offsetting any GHG

reductions achieved in the project area by increasing harvest or tree removals elsewhere in your entity. If your total entity carbon stocks are decreasing over time and you are not implementing a forest project, the Registry urges you to do so pursuant to the FPP so you can qualify to have these GHG reductions verified.

K. Reporting Non-CO_2 Emissions

Most forestry activities designed to increase carbon stocks are likely to have few anthropogenic biological greenhouse gas emissions associated with them. [11, 12] There are some exceptions however that can include use of fertilizer to enhance tree growth, forested wetland flooding or drainage, use of nitrogen fixing trees, and biomass burning, for instance in site preparation. For many cases where anthropogenic forest related activities do result in non-CO_2 emissions or removals, these effects are small relative to changes in carbon stocks.

During your first three years of reporting to the Registry, you are encouraged, but not required to report non-CO_2 emissions. Beginning with your 4th year of reporting, you must estimate emissions associated with any known likely source of non-CO_2 emissions. The Registry considers the following activities to be likely sources of non-CO2 emissions:

- Use of fertilizer
- Planned wetland restoration
- Cultivation of Nitrogen-fixing trees
- Prescribed biomass burning

The Forest Sector Protocol does not currently provide its own explicit methodologies for reporting non-CO2 emissions associated with these activities. Instead if reporters have engaged in any of the activities list above they should consult the Inter Governmental Panel on Climate Change's *Good Practice Guidance for LULUCF* (available at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf_contents.htm), Chapter 4 (Section 4.3.3.6). The Registry will continue to work to develop its own explicit California specific guidance.

[11] Anthropogenic non-biological emissions such as those associated with the use of vehicles, harvesting or site preparation equipment should be reported as part of the non-biological emissions report, as directed by the General Reporting Protocol.

[12] Brown, S., O. Masera, and J. Sathaye. 2000. Project-based activities. In R. Watson, I. Noble, B. Bolin, N. H. Ravindranath, D. J. Verardo and D. J. Dokken (eds.), Land use, land-use change, and forestry; Special Report to the Intergovernmental Panel on Climate Change, Cambridge University Press, Ch. 5, pp.283-338.

VII. Verification

Introduction

Verification of your entity's carbon stocks over regular intervals is required to assess performance and changes in entity-wide carbon stocks over time. This information is also necessary to test any earlier estimations made regarding increases or decreases in carbon stocks, if an entity baseline was chosen.

Verification is mandatory for all required GHG emission data reported to the Registry, both biological and non-biological. While your biological carbon stocks and emissions must be verified over six-year cycles, your non-biological GHG emissions must be verified annually. *Please refer to the General Reporting Protocol for information on verifying your non-biological GHG emissions.*

Rationale for Verification

The Registry's verification process requires you to hire an approved 3rd party verifier (listed on the Registry's website: www.climateregistry.org) to review and assess your reported required data to confirm that you have adhered to the Registry's reporting protocols and have compiled your GHG inventories accurately each year. This process is an integral component of the Registry's program. It helps to ensure the consistency and credibility of the GHG data reported across organizations, which, in turn enables the State of California to consider your verified GHG data if/when it is affected by regulation in the future. In addition, the verification process provides confidence to the public that the GHG information you report is accurate.

Verification References

In addition to the information provided in this section, the key principles of verification and the complete verification process are described in the General Reporting Protocol. You should familiarize yourself with this chapter and the provisions therein. In addition, Annex A of the Registry's Verification Protocol contains guidance for how verifiers must conduct the verification activities for forest entities. You may find it helpful to familiarize yourself with this Annex as well to fully understand the verification activities related to the forest sector.

Transparency

The Registry requires GHG data transparency for forest entity reporting, since this data will likely be of interest to and potentially used by a variety of stakeholders after it is reported to the Registry. To uphold this principle, forest entities must disclose all forest activities that may impact their C stocks (voluntary agreements/commitments, etc.) beyond the specific GHG data required by the Registry. Such transparency will help to ensure the environmental integrity of the data and assist stakeholders to better understand and interpret the GHG data resulting from the Registry's program.

Contextual Overview of Verification in Project-level Reporting Process

The following list provides an overview of the reporting process as context for the verification process for a forest entity. If you are also reporting a forest project, you will notice that project-level process differs slightly from the entity level, as it includes an additional optional step – project prescreening.

1. Establish entity boundaries, baselines and reporting responsibility
2. Complete entity summary worksheet
3. Initiate the reporting process
4. Conduct direct sampling of the entity forest area
5. Report biological data to the Registry via CARROT
6. *Verify the entity data*
7. *Submit verification paperwork to the Registry*

The Verification Cycle and Direct Sampling

Direct sampling is a required component of the verification process. As described in Part VI, you will undertake direct sampling in the monitoring process. As a part of the verification process, the verifier will also undertake direct sampling of a sub-sample of carbon inventory plots. This direct sampling by the verifier will represent all the carbon pools selected and measured for the initial inventory. The following paragraphs and table describe the verification cycle, as it relates to direct sampling and monitoring.

The standard required time intervals for a verifier's direct sampling of representative sample plots is a minimum of every six years. If you wish to verify your data on a more frequent basis (more than every 6 years), you are able to do so. Table B below outlines the time intervals for verification and the annual monitoring reports. While the Table reflects a twelve-year period, these intervals would extend throughout the duration you report to the Registry.

Table B: Verification Cycle and Review of Monitoring Reports by Verifier

Year	***Biological Emissions & C Stocks***	***Non-Biological Emissions***
Year 1	Conduct assessment of C stocks and stock change resulting in emissions reductions	Annually conduct verification activities to assess non-biological GHG Emission Report. (See the GCP for guidance on the verification process for non-biological GHGs.)
Years 2 – 5	Review Annual Monitoring Report	
Year 6	Conduct assessment of C stocks and stock change resulting in emissions reductions	
Year 7 (Repeat Year 1)	Conduct assessment of C stocks and stock change resulting in emissions reductions	
Years 8 – 11 (Repeat Years 2- 5)	Review Annual Monitoring Report	
Year 12 (Repeat Year 6)	Conduct assessment of C stocks and stock change resulting in emissions reductions	

VERIFICATION OF BIOLOGICAL INVENTORY DATA WILL ONLY OCCUR IN A YEAR WHEN A FULL VERIFICATION CYCLE OF YOUR ENTITY DATA IS COMPLETED.

Forest Entity Verification Responsibilities

Overview of Responsibilities:

To implement and complete the verification process for your forest entity, you must conduct the following five steps:

1. Review verification checklist and compile/organize info (see table below)
2. Review and finalize GHG data entered into CARROT
3. Hire verifier
4. Answer questions and supply requested information to your verifier as they review your monitoring report and/or conduct direct sampling verification activities
5. Discuss and understand the verification documentation that the verifier prepares for you

Review verification checklist and compile/organize data
After you have entered your forest entity information into CARROT, you can access a verification checklist online. This checklist will provide a list of documents you will want to have ready for your verifier, as they will likely request the information from you when they are conducting the verification activities. Reviewing this checklist in advance of meeting with your verifier will save you time and money, as you will be prepared to answer your verifier's questions when they arrive. A sample checklist is shown in Table C

Table C. Sample Checklist: Documents to be Reviewed for Verification of a Forest Entity

	Documents
Identifying Emission Sources	
Emission Source/Carbon Pool Inventory	Map of forest entity that includes: Entity boundaries Acreage Latitude/longitude Existing land cover & land use Topography Forest vegetation Site classes Entity Summary
Understanding Management Systems and Methodologies	
Responsibilities for Implementing Forest Management Plan	Organization Chart, Forest Management Plan or functional equivalent
Training	Training or Policy Manual, Procedures Manual
Methodologies	All Protocols and/or calculation methodologies used (in addition to the Registry's General Reporting Protocol) Explanation of sampling plan (including stratification if used) Documentation of any customized sampling or calculation methodology Documentation of baseline assumptions and calculations/projections, if appropriate
Verifying C Stocks and Emission Estimates	
Direct sampling estimates	Forest entity's direct sampling results from sample plots
Annual monitoring reports	Copies of annual monitoring reports and supporting documentation
Model assessment	Predictions from models/stand plots Documentation on who ran the model, description of model, and source of model

Review and finalize GHG data entered into CARROT
Review the GHG data that you entered into the CARROT for the reporting year for both completeness and accuracy. Submit your data as "verification ready." This will "freeze" your data, so that you cannot make any changes to the data without creating a new data revision. Once the data is "verification-ready," it will be visible to your chosen verifier in CARROT.

Hire verifier
If you have not done so already, you should hire an approved verifier. Remember that your verifier must be approved as a "forest sector verifier." You can enter into a multiple year contract with a verifier for up to 6 years, as stipulated in the General Reporting Protocol. The Registry strongly recommends entering into a 6-year contract with your verifier.

The State of California and the Registry will "approve" verifiers that are qualified to review your project on an annual basis. A forest sector verifier is a verification firm that

has been approved by the State and the Registry as a "general verifier" that has also demonstrated its ability to assess your biological stocks and emissions and nonbiological emissions. Consequently, you will only need to hire one verifier to review both your biological and non-biological information.

Approved verifiers and their contact information are listed on the Registry's website (www.climateregistry.org). Please refer to the Verification Protocol if you need additional guidance in selecting a verifier.

Answer questions and supply requested information to your verifier as they review your monitoring report and/or conduct direct sampling verification activities

As your verifier conducts the verification activities, they will ask you questions and may require additional information from you. If you make yourself available and answer their questions in a timely manner, it will expedite the completion of your data's verification

Discuss and understand the verification documentation that the verifier prepares for you

If you are verifying your forest project, your verifier will prepare the following verification documentation for you:

- Verification Log—Biological Inventory*
- Verification Log--Non-biological Inventory
- Verification Report (Report that summarizes the verification activities and outcomes of both the biological and non-biological inventory)
- Verification Opinion—Biological Inventory*
- Verification Opinion—Non-biological Inventory

You should discuss the verification documentation and the outcome of the verification activities with your verifier.

If the verifier finds material misstatements in your forest entity biological inventory, you may correct the sampling or calculation error, if possible, and re-verify your data. If it is not possible to correct the material misstatement in your inventory, then you must establish a new base year using the next year in which you have verifiable data. Once your data is deemed verifiable by your verifier, you are ready to complete the reporting process

Note: your verifier cannot act as a consultant (as this is a conflict of interest), and therefore may not suggest how to correct any material misstatements. Your verifier can only identify areas that are not verifiable, and explain why.

VIII. Completing the Reporting Process

You are now ready to complete the Registry's reporting process. At this point you should have:

- Reported your biological inventory for the reporting year into CARROT
- Successfully completed the verification activities
- Verification Logs and Verification Opinions for your biological and non-biological inventories
- Confirmation from your verifier that they have completed your verification form in CARROT

You must do two final things to complete the annual reporting process:

1. Submit your GHG data for this reporting year to the Registry via the CARROT
2. Mail a hard copy of your Verification Log(s), Monitoring Report and Verification Opinions to the Registry.

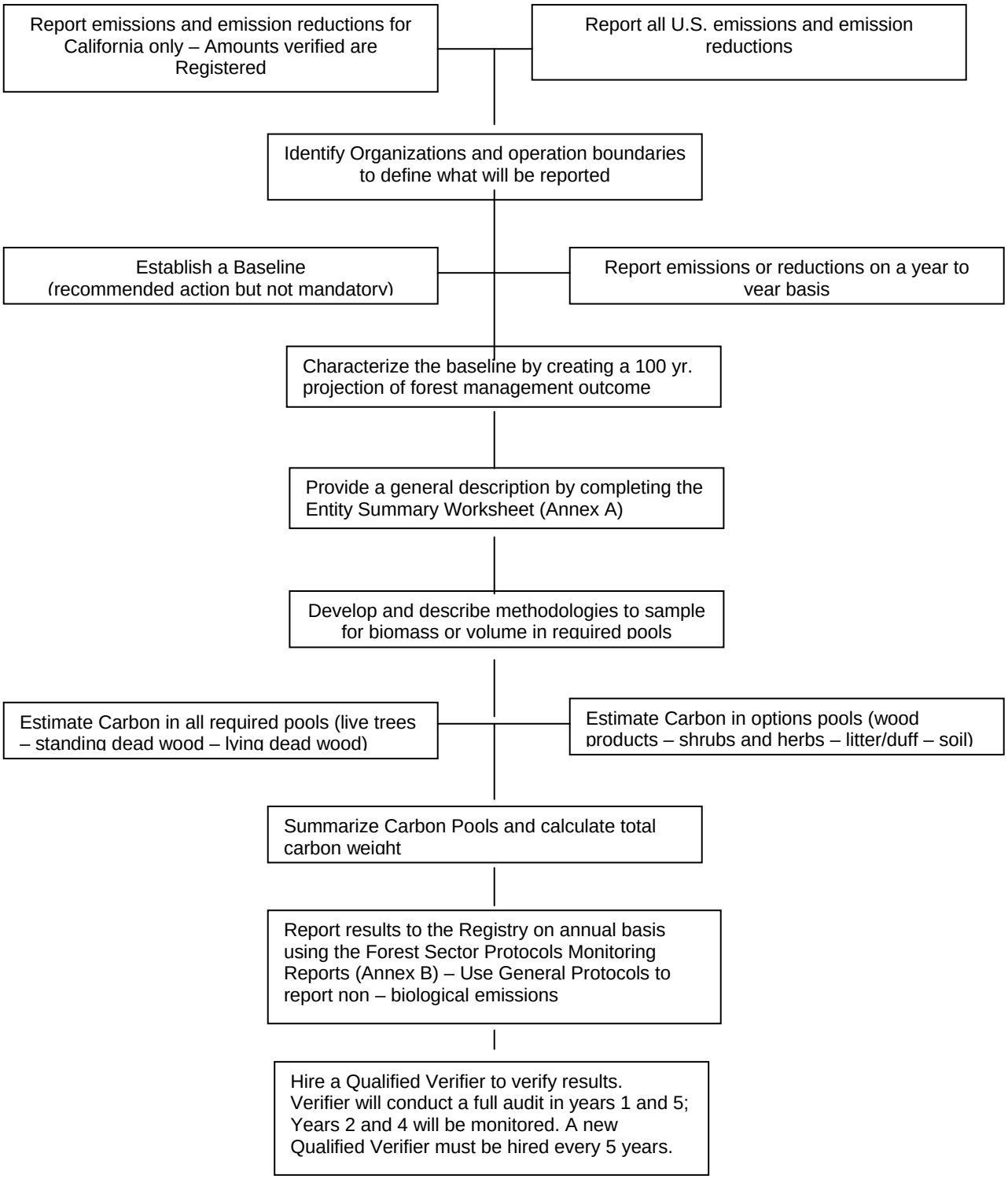
Once the Registry receives your submission and documentation, it will review your annual report. Upon acceptance of your annual report, the Registry will send you an email confirmation and mail you a verification verificate.

At this point, your aggregated GHG data for this reporting year will become available to the public via the CARROT.

Congratulations! You have successfully completed the annual reporting process!

IX. ANNEXES

ANNEX A - Forest Protocol Entity Process



ANNEX B - Forest Entity Summary

Please use this worksheet to complete your initial Biological Forest Entity Summary

Name of Entity:
Name of person completing summary:
Date of initial reporting year:

Entity Geographic Boundaries:

Organizational Boundaries:

Operational Boundaries:

Required direct pools identified for entity reporting - circle all those that apply

Live Trees Standing Dead Biomass Lying Dead Wood

Optional direct pools identified for entity reporting - circle all those that apply

Soil Litter and duff Herbaceous understory/shrubs Wood Products

Baseline Characterization

If you are establishing an entity baseline, please describe the practices/management as well as the management objectives that are intended to occur over the entity forest area in the next 100 years.

Please also insert or attach a graph similar to Example L, which depicts your entity baseline as carbon stocks over the 100 year projection.

Physical description of forest entity area: please provide the following information

- Forest entity property boundaries -
- Acreage of entity forest area –
- Latitude/longitude –
- Existing land cover and land use-
- Topography -
- Forest Vegetation -
- Site Classes -
- Wildlife Habitat Relationship (WHR) Classes -
- Watercourses -
- Description of land pressures and climate regime **–**

ANNEX C - Forest Entity Annual Monitoring Report

Use this template to complete your annual monitoring report for submission to the Registry:

Name of Entity:
Name of person completing the Report:
Date:
Reporting year:
First year reported to the Registry:

1. Please state your estimated total carbon stocks and emissions for the year:

2. Based on your entity's carbon projections for this reporting year, did your on-site carbon increase, decrease, or remain the same?

    a. If your on-site carbon changed, by how much did it change (in tons?)?

    b. What caused the change in your carbon stocks? (please explain any disturbances (tree removals, natural significant disturbances etc.) that occurred, the date of the disturbance(s), the extent of the disturbance and whether it was originally included in your original projected entity activities)

    c. Please describe any significant forest growth, restoration, or planting that took place during the reporting year.

3. Have your organizational boundaries changed in this reporting year (mergers, divestitures, etc.)?

    a. If so, please explain and also quantify the associated change in carbon stocks.

4. Did you experience any natural significant disturbances within your entity in this reporting year?

    a. If yes, please explain.

    b. If yes, also estimate when you plan your next direct measurement to take place (must be within 3 years of the time of the significant disturbance).

5. Has your organization changed its operations outside of its reporting boundary as a result of participating in the Registry? If yes, please describe. (For example, if an organization is reporting its CA emissions, did it change its operations outside of the state as a result of participating in the Registry?)

6. Do you expect your organization's GHG emissions in the areas outside of your organization's reporting boundary (but within your organization) to change as a result of your participation in the Registry? If yes, please explain.

7. Are you managing and monitoring your forestland in a manner consistent with your projected management and monitoring plans?

    a. If not, please explain the deviation.

8. Are you currently reporting any forest projects to the Registry? If so, what type?

9. Have you initiated any new forest projects in this reporting year?

10. Have you, to the best of your knowledge followed the reporting requirements set forth in the Forest Sector Protocol?

11. Is there any information you would like to additionally report to the Registry to describe your forest activities this year?

    a. If yes, please describe.

I have completed and/or reviewed this form, and believe it contains the most accurate data and information possible.

_____	_____
Signature of person completing form	Signature of officer
_____	_____
Printed name	Printed name

ANNEX D - A Comparison of Entity and Project Reporting

Section	Entity Level Reporting **(Forest Sector Protocol)**	Project Level Reporting **(Forest Project Protocol)**
Definition	Forest entities are individuals or legally constituted bodies that own at least 100 acres of trees. Entity level reporting requires the forest entity to report all GHG emissions that the entity is responsible for, both biological and non-biological. Entity-wide reporting provides an overview of an organizations emissions from all of its operations.	Forest projects are planned sets of activities that occur on some portion of an entity and are intended to achieve GHG reductions. A forest project should remove, reduce or prevent carbon dioxide emissions in the atmosphere by conserving and /or increasing onsite forest carbon stocks.
Reporting Area	At an entity level the area reported on is the entire forest entity owned by the individual, government or organization that is reporting.	At the project level, the individual, organization or government reporting may report on some portion of the entity, or the project may encompass the entire entity.
Baseline Requirements	At the entity level a baseline is optional but encouraged. An entity may either create a baseline and track its carbon stocks against it or simply report carbon stocks on an annual basis.	At the project level a baseline is required and entities must track changes in carbon stocks against that baseline.
Baseline Characterization	At the entity level the baseline is a long-term projection of an entities forest carbon stocks over one-hundred years that is based on an entities forecasted management practices and goals.	At the project level the baseline is a long-term projection of the forest management practices or activities that would have occurred (or absence thereof) within a projects physical boundaries in the absence of the project. The baselines for the three project types are characterized by mandatory land use statutes and regulations, existing practices and/or threats of land use change.
Land Management and Environmental Co-Benefits	Forest entity reporting does not require that any specific land management objectives be met.	At the project level a forest entity is required to secure their project with a perpetual conservation easement and permanently dedicate the land to forest use. All forest projects are required to promote and maintain forest types that are native to the project area. In addition, forest management projects must use natural forest management practices.

Leakage	Analyzing the affects of leakage is not required at the entity level.	Activity shifting leakage that may have been created in the entity due to the project must be assessed. Reporting market leakage is optional.
Verified GHG Reductions and Emissions	Changes in carbon stocks from year to year do not count as verified emissions reductions at the entity level. Emissions are measured over time.	Emissions reductions can only occur at the project level through the removal or reductions of CO_2 and prevented CO_2. Project emissions are measured as the difference between the project activity and the project baseline.
Quantifications Section Statistical Confidence Intervals	For estimates of reported carbon pools, the standard error of the mean must be within 20% of the estimate of the mean for the estimate to be accepted by the Registry.	For estimates of the reported carbon pools, the sampling error at the 90% confidence interval must be less than 20% of the estimate of the mean for the estimate to be accepted by the Registry. Deductions apply to mean estimates of the carbon pools if the sampling error at the 90% confidence interval is 5% of the mean estimate or greater. A higher level of confidence is required at the project level because the carbon storage reported can be verified as GHG emissions reductions.
Quantifications Section Confidence Level Deductions	Deductions are not taken from volume estimates at the entity level.	At the project level, deductions based on the level of confidence of measurement samples are taken from estimates of tree bole volume, standing dead biomass volume, lying dead wood volume, shrub and herbaceous understory volume and and soil carbon volume. Project reporting demands more accuracy in its measurements sections because carbon storage reported will be verified as GHG emissions reductions or emissions.

ANNEX E - References

Sampling Methodology References

Avery, T. and Burkhardt, H. 1994. Forest measurements. McGraw-Hill. 408 pp.

Brown, J. K. 1974. Handbook for inventorying downed woody material. General Technical Report INT-16. USDA Forest Service Intermountain Forest and Range Experiment Station: Ogden, Utah. 24 pp.

Brown Sandra, David Shoch, Tim Pearson and Matt Delaney 2004. "Methods for Measuring and Monitoring Forest Carbon Projects in CA." Winrock International: Arlington VA, for the Regents of California/ California Institute of Energy Efficiency.

Bell, J. and Dilworth, J. 1985. Log scaling and timber cruising. Oregon State University Book Stores, Inc.

Halpern, Charles B.; Miller, Eric A.; Geyer, Melora A. 1996. Equations for predicting aboveground biomass of plant species in early successional forest of the western Cascade Ranges, Oregon. Northwest Science. 70(4): 306-320

Hamburg, S.P. 2000. Simple rule for measuring changes in ecosystem carbon in forestry offset projects. *Mitigation and Adaptation Strategies for Global Change.* 5:25-37

Harmon, M.E. and J. Sexton. 1996. Guidelines for measurements of woody detritus in forest ecosystems. US LTER Publication No. 20. U.S. LTER Network Office, University of Washington, College of Forest Resources, Seattle, WA. 73 pp. (http://www.lternet.edu/documents/Publications)

Harmon, M.E., K.J. Nadelhoffer, and J.M. Blair. 1999. Measuring decomposition, nutrient turnover, and stores in plant litter pp. 202-240 In Robertson, G.P., C.S. Bledsoe, D.C. Coleman, and P Sollins editors, Standard Soil Methods for Long Term Ecological Research, Oxford University Press, New York.

Larsen, David R. 1999. *Course Woody Debri Estimation* The School of Natural Resources, University of Missouri-Columbia <http://www.snr.missouri.edu/natr211/pdf/cwd.pdf> May 4, 2004

MacDicken, K.G. 1997. A guide to monitoring carbon storage in forestry and agro-forestry projects. Winrock International Institute for Agricultural Development pp. 87

Robertson, G.P., C.S. Bledsoe, D.C. Coleman, and P. Sollins 1999. Standard Soil Methods for Long Term Ecological Research, Oxford University Press, New York.

Sampson, Neil. 2002. *Monitoring and Measuring Wood Carbon* The Sampson Group <http://www.sampsongroup.com/Papers/Monitoring%20and%20Measuring%20Wood%20Carbon.pdf**>** May 4, 2004

Van Wagner, C. E. 1968. The line intersect Method in forest Fuel Sampling. *Forest Science* 14(1): 20-26.

Warren, W. G. and P. F. Olsen. 1964. A line intersect technique for assessing logging waste. *Forest Science* 10:267-276.

Wenger, K.F. (ed.) 1984. Forestry handbook. 2d ed. John Wiley & Sons, New York. 1335 pp.

U.S. Department of Agriculture, Forest Service. 2003. Forest inventory and analysis national core field guide, volume 1: field data collection procedures for phase 2 plots, version 1.7 U.S. Department of Agriculture, Forest Service, Washington Office. Internal Report. On file with: U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis, 201 14th Street Washington D.C. 20250

U.S. Department of Agriculture, Forest Service 2003. Forest inventory and analysis methods for phase 3 measurements. Down Wood Debris and Fuels. U.S. Department of Agriculture, Forest Service, Washington Office. http://fia.fs.fed.us/library.htm#Manuals

U.S. Department of Agriculture, Forest Service 2003. Forest inventory and analysis methods for phase 3 measurements. Soil Measurement and Sampling U.S. Department of Agriculture, Forest Service, Washington Office. http://fia.fs.fed.us/library.htm#Manuals

Wood Products References

Miner, Reid. 2004. "Characterizing carbon sequestration in forest Products in use" National Council for Air and Stream Improvement. http://www.ncasi.org/

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XI. Bibliography

Birdsey, R.A. Carbon storage for major forest types and regions in the conterminous United States. In: Sampson, R.N. and Hair. D. (eds.) Forests and Global Change
Vol. 2: Forest Management Opportunities, American Forests, Washington D.C. pp. 23-39 and App. 2 1996.

Brown, Sandra "Guidelines for inventorying and monitoring carbon offsets in forest-based projects" Winrock International. 1999. http://www.winrock.org/REEP/Guidelines.html

Brown, Sandra "Measuring, monitoring and verification of carbon benefits for forest-based projects" Philosophical Transactions: Mathematical, Physical & Engineering Sciences 360. 1797:1669-1683 (2002).

Cairns, M. A., S. Brown, E. H. Helmer, and G. A. Baumgardner. 1997. Root biomass allocation in the world's upland forests. *Oecologia* 111:1–11. D

Dixon R.K., et al. "Carbon pools and flux of global forest ecosystems. Science 263: 185-190. (1994).

Ellis, Jane "Developing Guidance on Monitoring and Project Boundaries for Greenhouse Gas Projects" Organisation for Economic Co-operation and Development. 2002. http://www.oecd.org/dataoced/44/50/2757386.pdf

Ellis, Jane and Martina Bosi "Options for project emissions baselines Organisation for Economic Co-operation and Development and the International Energy Agency, 1999. http://www.ghgprotocol.org/docs/options.pdf

Hamburg, Steven. "Simple rules for measuring changes in ecosystem carbon in forestry-offset projects" Mitigation and Adaptation Strategies for Global Change, 5:25-37 Netherlands: Kluwer Academic Publishers, 2000.

Intergovernmental Panel on Climate Change, Working Group III to the Third Assessment Report, Bert Metz, Ogulade Davidson, Rob Swart, Jiahua Pan, Eds. Climate Change 2001: Mitigation, Cambridge University Press, 2001

Koch P. "Estimates by species group and region in the USA of I. Below-ground root weight as a percentage of oven-dry complete-tree weight; and II. Carbon content of tree portions. Consulting Report p. 23. Unpublished, (Sampson and Dwight, 1996) p 15, 1989.

MacDicken, K.G. “A guide to monitoring carbon storage in forestry and agro-forestry projects” Winrock International Institute for Agricultural Development. 1997. <http//www.winrock.org/REEP/PDF_Pubs/carbon.pdf>

Mayer, Kenneth E. and William F. Laudenslayer Jr. Eds. A Guide to Wildlife Habitats of California. Sacramento, CA: California Department of Fish and Game, 1988.

Prisley, S.P. and M.J. Mortimer. General guidelines for forest carbon accounting models: a synthesis of literature on evaluation of models for policy applications. In Press

Row, C. and R.B. Phelps “Wood Carbon flows and storage after timber harvest”. In: (Sampson, R.N. and D. Hair, eds.) Forests and Global Change Vol 2: Forest Management Opportunities for mitigating carbon emissions. P.27-58 American Forests, Washington D.C. 1996.

Sampson, Neil R. and Dwight Hair, Eds. Forest and Global Change Volume 2: Forest Management Opportunities for Mitigating Carbon Emissions. Washington D.C.: American Forests, 1996.

Schwarze, Reimund, John O. Niles and Jacob Oleander, “Understanding and managing leakage in forest-based greenhouse-gas-mitigation projects” Philosophical Transactions: Mathematical, Physical & Engineering Sciences 360. 1797:1685-1703. (2002).

Skog, Kenneth E. and Garaldine A. Nicholson “Carbon sequestration in wood and paper products” USDA Forest Service General Tech Report RMRS-GTR-59 Chapter 5, 2000. http://www.fpl.fs.fed.us/documents/pdf2000/skog00b.pdf

Standards Australia Committee EV-015 Carbon Accounting for Greenhouse Sinks: Part 1 Afforestation and Reforestation. Sydney Australia: Standards Australia International, 2002.

U.S. Department of Energy “Sector Specific Issues and Reporting Methodologies Supporting the General Guidelines for the Voluntary Reporting of Greenhouse Gases under Section 1605(b) of the Energy Policy Act of 1992” Part 5 of 6 Forestry Sector. 1996. http://www.eia.doe.giv/pub/oiaf/1605/cdrom/pdf/gg-v2-5-forest.pdf

Willems, Stephane “Framework for baseline guidelines” Organisation for Economic Cooperation and Development. 2002. http://www.ghgprotocol.org/docs/baseline-framework.pdf

Watson, Robert T., Ian R Noble, Bert Bolin, N.H. Ravindranath, David J. Verardo, and David J. Dokken Land Use, Land-Use Change, and Forestry. Cambridge,

UK: Cambridge University Press, Intergovernmental Panel on Climate Change, 2000.

World Resources Institute “The Greenhouse Gas Protocol: Project Quantification Standard Roadtest and Review Draft” World Resources Institute and World Business Council for Sustainable Development 2003. http://www.ghgprotocol.org/docs/GHG%20Protocol_ProjectRTDraft_linenumbers_Sept_2003.pdf

World Resources Institute “The Greenhouse Gas Protocol: A corporate accounting and reporting standard (Revised edition) 2004. http://www.wristore.com/ghgprotorev.html