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Demonstration of conservation-based forest management to sequester carbon on the Bascom Pacific Forest

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DEMONSTRATION OF CONSERVATION-BASED FOREST MANAGEMENT TO SEQUESTER CARBON ON THE BASCOM PACIFIC FOREST

Jonathan Remucal, C. Best, L. Wayburn, M. Fehrenbacher, and M. Passero.

Pacific Forest Trust

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STATE OF CALIFORNIA ENERGY COMMISSION

Arnold Schwarzenegger
Governor

Demonstration of Conservation-Based Forest Management to Sequester Carbon on the Bascom Pacific Forest

PIER PROJECT REPORT

Prepared For:

California Energy Commission
Public Interest Energy Research Program

Prepared By:

PACIFIC FOREST TRUST

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Preface

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (Energy Commission) conducts public interest research, development, and demonstration (RD&D) projects to benefit the electricity and natural gas ratepayers in California. The Energy Commission awards up to $62 million annually in electricity-related RD&D, and up to $12 million annually for natural gas RD&D.

The PIER program strives to conduct the most promising public interest energy research by partnering with RD&D organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following RD&D program areas:

- Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Environmentally Preferred Advanced Generation
- Energy-Related Environmental Research
- Energy Systems Integration

Demonstration of Conservation-Based Forest Management to Sequester Carbon on the Bascom Pacific Forest is a final report for the West Coast Regional Carbon Sequestration Partnership – Phase II (contract number 500-02-004, work authorization number MR-06-03L. The information from this project contributes to PIER's Energy-Related Environmental Research program.

For more information on the PIER Program, please visit the Energy Commission's Web site at www.energy.ca.gov/pier or contact the Energy Commission at (916) 654-5164.

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Abstract

The Bascom Pacific Conservation Forestry Project was initiated as part of the West Coast Regional Carbon Sequestration Partnersthip (WESTCARB) in order to demonstrate how the baseline and project activities associated with the conservation-based management of a commercially productive forestland site in northern California would be interpreted and projected if a carbon dioxide emissions reductions project were undertaken in accordance with version 2.1 of the Forest Project Protocol of the California Climate Action Registry (now the Climate Action Reserve). After measuring the initial forest carbon stocks on the Bascom Pacific Forest, project activities based on the forest management guidelines outlined in the conservation easement on the property were identified that would create emissions reductions on the project site relative to a baseline scenario based on harvesting the greatest amount of timber feasible and practicable under applicable forest laws. The costs and benefits of undertaking a forest management project for the purpose of registering forest carbon stock changes with the Climate Action Reserve were evaluated, including an assessment of ways the Forest Project Protocol may be improved to increase its practicality and effectiveness. Since the Forest Project Protocol was updated from version 2.1 to version 3.1 near the completion of this study, a number of changes made in the updated version were referenced throughout the report, including a brief discussion of how these changes may affect the subject project.

Executive Summary

Introduction

The following report summarizes the Bascom Pacific Conservation Forestry Project as part of the West Coast Regional Carbon Sequestration Partnership (WESTCARB) – Phase II. The project was initiated with the intent to achieve the following:

- Demonstrate how baselines and project activities associated with the conservation-based management of a commercially productive forestland site in northern California would be interpreted and projected on this site if a carbon dioxide (CO_2) emissions reduction project were undertaken in accordance with the California Climate Action Registry Forest Project Protocol (Version 2.1) (which, together with the associated general reporting and verification protocols are referred to herein as the "Forest Protocols")
- Identify specific management activities that would create carbon reductions on this site
- Evaluate the costs and benefits of the Forest Protocols with respect to undertaking a forest management project for the purpose of registering forest carbon stock changes with the Climate Action Reserve ("Reserve").

Purpose

The initial conditions on the Bascom Pacific project site (hereafter Bascom Pacific Forest) were defined as the amount of forest carbon stocks on site prior to the start of project activities. Initial conditions were established by directly sampling carbon stocks. This was done by performing both a conventional timber inventory, as is typically used in commercial timber applications, and a lying dead wood inventory. Methodologies for both the conventional commercial timber inventory and the lying dead wood inventory are provided below. Conventional inventory measurements are summarized by stand, whereas lying dead wood measurements are summarized by Public Land Survey System section. Summary information from each inventory includes conversions of data to carbon values.

Project Objectives

The direct sampling efforts on the Bascom Pacific Forest were designed to generate inventory data that achieve the following:

1. Provide current estimates of the standing timber volume and biomass.
2. Provide current estimates of biomass in lying dead wood.
3. Support timber and habitat management activities.
4. In the case of the 2006 inventory, support projections of future timber resources and carbon stocks using the CACTOS growth model (Wensel *et al*. 1986; http://www.cnr.berkeley.edu/~wensel/cactos/cactoss.htm).
5. In the case of the 2008 inventory update, monitor project activities and resulting changes to carbon stocks.

Project Outcomes

Once initial conditions for the Bascom Pacific Forest were established, changes to future carbon stocks were modeled pursuant to the requirements of the Forest Protocols to evaluate the difference between projected carbon stocks under two distinct management scenarios: *baseline activities* and *project activities*. The baseline management scenario under version 2.1 of the Forest Protocols is based on how the forest would be managed if the landowner were to realize timber harvest volumes to the greatest extent feasible and practicable as allowed under applicable forest management laws, in this case the California Forest Practice Act/Rules. The project activity scenario for the Bascom Pacific Forest is based on management that follows the conservation easement on the property and is intended to sequester and store more carbon stocks over time than the baseline activity scenario. Those project activity carbon stocks that are stored above and beyond baseline activity stocks are considered *additional* carbon stocks, representing net gains due to sequestration and avoided depletion in reference to the "business as usual" baseline. Based on the baseline and project activities modeled, this study shows that over 1 million tons of additional metric tons of CO_2, or 118 metric tons of CO_2 per acre, would be generated by the end of the 100-year project lifetime.

Conclusions

Over the life of the project, 447,877 thousand board feet (MBF) of timber are harvested under the baseline activity scenario, whereas 417,563 MBF are harvested under the project activity scenario (Tables 14 and 15). The amount of timber harvested in any given period of time varies considerably under the baseline activity scenario, with significant pulses during the periods in which clearcutting occurs, more modest harvest volumes when intermediate thinning takes place, and no volume harvested in some periods as standing timber volume is allowed to accumulate on clearcut sites. Although the baseline activity scenario exhibits an average harvest rate of about 4,475 MBF per year, as much as 7,413 MBF per year are harvested per year during the initial clearcut phase and up to 14,820 MBF per year in the second clearcut phase, but only between about 1,000 and 3,000 MBF per year during intermediate thinnings and 0 MBF during fallow years. The wood products carbon pool reflects these changes by accumulating rapidly during clearcutting phases, and more slowly during intermediate thinning phases (Figure 7). But during the periods in which no harvesting occurs, decay of existing wood products leads to a slight decrease in the overall stocks in this pool. At the end of the project lifetime, the baseline activity scenario has a total of 88,775 metric tons of carbon in the wood products pool.

Combining the wood products pool with the standing live tree, standing dead tree and lying dead wood pools increases the amount of carbon stored under both the baseline activity and project activity scenarios (Figure A1). When the baseline values are averaged over the project lifetime, inclusion of wood products increases the baseline average by 179,064 tons of CO_2. Incorporating wood products also increases the cumulative emissions reductions at the end of the project lifetime by 132,208 tons of CO_2. However, cumulative emissions reductions including wood products remains lower than emissions reductions without wood products until 2066, at which point emissions reductions including wood products is greater through the remainder of the project lifetime.

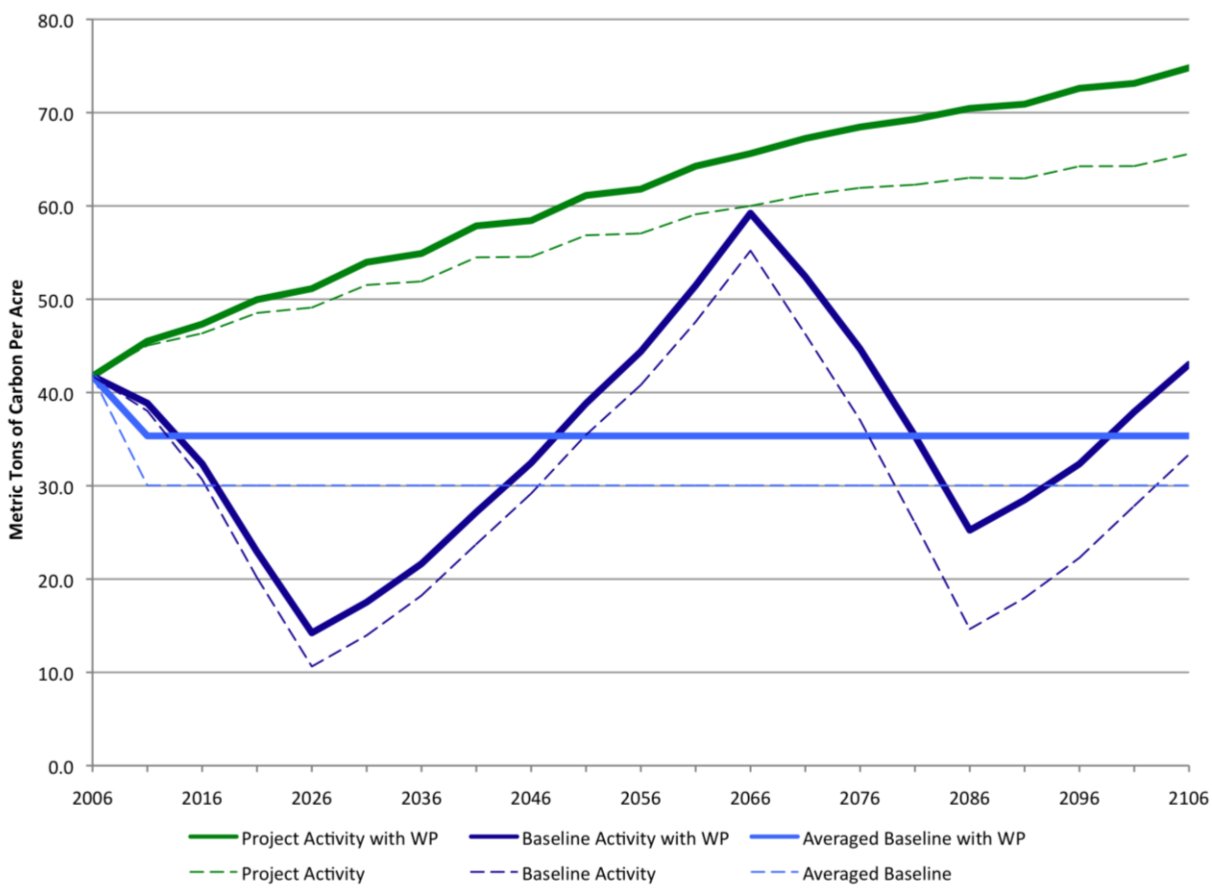

Figure A1. Baseline and project activity carbon stocks, both with and without wood products pool stocks, over the 100-year project lifetime on a per acre basis. The averaged baseline activity value is also shown. All scenarios have the same initial carbon stocks at the project start date in 2006. The averaged baseline curve begins at this same starting value, but achieves the average value by the end of the first 5-year reporting period by being reduced annually in equal increments.

Overall, the results of the application of version 2.1 of the Forest Protocols appear to provide practical but rigorous accounting of emissions reductions to internationally acceptable standards. Nonetheless, there are a number of areas were we recommend changes to provide for more efficient and accurate application, many of which have been incorporated into version 3.0. In considering the costs and returns of a project such as Bascom Pacific, under the assumptions used in a pro forma analysis, we believe the potential financial returns from an emissions reduction project provide an incentive for landowner participation, while fostering long term forest conservation and net gains from long term reduction of CO_2 emissions.

Recommendations

The initial conditions inventory, when properly specified, can be cost effectively undertaken concurrent with a conventional timber inventory but does add expense. The greater expense is due to the generally higher statistical confidence required in sampling[1] and the inclusion of additional inventory elements such as standing and down dead biomass. Further, the requirement for permanent marking of plot centers is a costly variance from the standard timber inventory practice of temporary flagging. Version 3.0 of the Forest Protocols eliminates the requirement for permanent monumenting, while still requiring temporary flagging so that verifiers can locate plot centers. In addition to the specific requirements of different project types under the Protocols, inventory costs vary with the size and heterogeneity of the property, not unlike timber inventories. Larger more homogenous properties will cost less to inventory than the mid-size, relatively diverse Bascom Pacific property.

Benefits to California

During the course of this project the Reserve initiated a stakeholder process to review, update and revise the Forest Protocols. The experience the authors gained in preparing this report helped inform the development of the revised Protocols, which are now published as version 3.0 (and subsequently updated to version 3.1). In addition, the Bascom Pacific Forest analysis provides an example for future improved forest management projects, so that project developers can have a sense of what to expect when undertaking such an endeavor and so that policymakers and the public can better understand the potential for real, lasting and verifiable emissions reductions to be achieved through changes in forest management.

[1] Lower sampling confidence intervals (i.e., greater than +/-5% at the 90% confidence interval)

1.0 Introduction

1.1 Project Overview and Objectives

The following report summarizes the Bascom Pacific Conservation Forestry Project as part of the West Coast Regional Carbon Sequestration Partnership (WESTCARB) – Phase II. The project was initiated with the intent to achieve the following:

- Demonstrate how baselines and project activities associated with the conservation-based management of a commercially productive forestland site in northern California would be interpreted and projected on this site if a carbon dioxide (CO_2) emissions reduction project were undertaken in accordance with the California Climate Action Registry Forest Project Protocol (Version 2.1) (which, together with the associated general reporting and verification protocols are referred to herein as the "Forest Protocols")
- Identify specific management activities that would create carbon reductions on this site
- Evaluate the costs and benefits of the Forest Protocols with respect to undertaking a forest management project for the purpose of registering forest carbon stock changes with the Climate Action Reserve ("Reserve").

We note that during the course of this project the Reserve initiated a stakeholder process to review, update and revise the Forest Protocols. The experience the authors gained in preparing this report helped inform the development of the revised Protocols, which are now published as version 3.0 (and subsequently updated to version 3.1). Throughout this report we reference a number of changes made to version 3.0 in comparison to 2.1 and how these changes could affect the subject project.

The initial conditions on the Bascom Pacific project site (hereafter Bascom Pacific Forest) were defined as the amount of forest carbon stocks on site prior to the start of project activities. Initial conditions were established by directly sampling carbon stocks. This was done by performing both a conventional timber inventory, as is typically used in commercial timber applications, and a lying dead wood inventory. Methodologies for both the conventional commercial timber inventory and the lying dead wood inventory are provided below. Conventional inventory measurements are summarized by stand, whereas lying dead wood measurements are summarized by Public Land Survey System section. Summary information from each inventory includes conversions of data to carbon values.

Once initial conditions for the Bascom Pacific Forest were established, changes to future carbon stocks were modeled to evaluate the difference between baseline activities and project activities. The Forest Protocols require that an analysis be conducted to project future carbon stocks under two distinct management scenarios: *baseline activities* and *project activities*. The baseline management scenario under version 2.1 of the Forest Protocols is based on how the forest would be managed if the landowner were to realize timber harvest volumes to the greatest extent feasible and practicable as allowed under applicable forest management laws, in this case the California Forest Practice Act/Rules. The project activity scenario for the Bascom Pacific Forest is based on management that follows the conservation easement on the property and is intended to sequester and store more carbon stocks over time than the baseline activity scenario. Those project activity carbon stocks that are stored above and beyond baseline activity stocks are considered *additional* carbon stocks, representing net gains due to sequestration and avoided depletion in reference to the "business as usual" baseline. Based on the baseline and project activities modeled, this study shows that over 1 million tons of additional metric tons of CO_2, or 118 metric tons of CO_2 per acre, would be generated by the end of the 100-year project lifetime.

We found the Forest Protocols to be a useful and useable tool for measuring changes to forest carbon stocks and estimating the emissions reductions that may be generated by a forest project, providing real net gains for the atmosphere and meaningful added financial value to forest owners. However, there are a number of ways in which the practicality and effectiveness of the Protocols can be and have been improved to increase the accuracy of emissions reductions estimates, reduce costs to project developers, and increase participation in the Reserve.

1.2 Climate Action Reserve Forest Protocol and Its Key Principles

The Forest Protocols (to reference both version 2.1 and the new version 3.0, please go to http://www.climateactionreserve.org/how/protocols/adopted-protocols/forest/current/) provide guidance for the voluntary registration and certification of greenhouse gas emissions and reductions from the forest sector. The Forest Protocols consist of three related Protocols that set consistent accounting standards and provide guidance for measurement and reporting at the entity and project levels, as well as for third-party certification (or "verification" as it is also known). The Forest Sector Reporting Protocol, in conjunction with the Reserve's existing General Reporting Protocol, governs the accounting and registration of a forest entity's "entity-wide" greenhouse gas (GHG) emissions, both biological and non-biological. The Forest Project Protocol provides guidance for the accounting and registration of forest project activities that are focused on GHG reductions, specifically reductions in biological emissions. Specific project types (or activities) include conservation-based forest management, reforestation and conservation (or avoided conversion). Guidance for third-party certification of entity and project GHG emission and reduction reporting is also provided in the Certification Protocol. The Bascom Pacific Project used the forest management guidance of the Project Protocol.

The specific requirements of the Reserve's Forest Project Protocol are derived from widely accepted greenhouse gas emission reduction principles. These principles include the requirements of establishing a **baseline**, calculating the **additionality** of project carbon stores, and assuring the **permanence** or durability of emissions reductions.

Baseline: The baseline reflects a business as usual scenario, or a characterization of what can reasonably be assumed would happen on the project site in the absence of the forest project activity. The baseline for a forest management project under the Forest Protocols assumes that business as usual would be for a landowner to manage the property to realize its economic value in a way that is legal and feasible. Version 2.1 of the Forest Protocol describes a standardized performance-based approach that captures the limits imposed by prevailing regulation of the property, in particular the silvicultural prescriptions of "Option C" in sections 913.11, 933.11 and 953.11 of article 3 of the California Forest Practice Rules (14 CCR), as well as any other rule or law that affects management activities. Other potential rules and laws that affect the baseline analysis include watercourse protection rules, endangered species laws, and any county ordinances, deed restrictions or other mandatory, enforceable constraints. This baseline scenario is then modeled to create a projection of total baseline forest carbon stocks throughout the 100-year timeframe.

Version 3.0 of the Protocol amends and expands on the Baseline methodology used in version 2.1, with the same goal of characterizing what reasonably can be assumed would happen in the absence of the project. The standardized guidance for a Baseline performance standard in version 3.0 can be applied in forest types across the U.S., not only in California, and defines different rules for projects depending on the volume of the initial project carbon stocks. The methodology uses a "Common Practice" performance standard and two tests: The regulatory test requires the project developer to demonstrate that the baseline activity complies with all applicable laws, regulations and Best Management Practices; the financial feasibility test requires that the project developer demonstrate that the baseline activity, including timber harvest and other management activities are financially feasible. As with version 2.1, the baseline relies on a computer simulation to project stocks over the 100 years of the project commitment period. The first step in estimating the baseline condition is to determine if the initial project live tree carbon stocks are above or below a metric meant to quantify Common Practice, or typical live tree carbon stocking that is the result of forest management for similar lands in the forest type and jurisdiction surrounding the property. The Reserve has utilized data for private forestlands developed by the USDA Forest Inventory and Analysis (FIA) program to develop a mean live tree stocks value to represent common practice. If a project's initial stocks are above Common Practice, Baseline live tree carbon values cannot fall below Common Practice. If a project's initial stocks are below Common Practice, Baseline live tree carbon values must not fall below historical levels (as defined). Once the carbon flux of the Baseline is modeled incorporating all required carbon pools, the results are averaged for the project lifetime. If for any reason that average value is below the initial starting live carbon stock value or the historic stocking level, then the highest of the values is used to estimate the Baseline condition.

Overall, the Baseline methodology in version 3.0 is expected to produce more conservative results. The potential relative impact on the hypothetical project that serves as the basis of this study is discussed later in this paper.

Additionality: Forests store CO_2 as carbon biomass naturally, yet all CO_2 stores in a forest do not yield certifiable emissions reductions. To produce qualifying emission reductions, a forest management project must also demonstrate additionality, or that the CO_2 stores that are being reported as the basis for emissions reductions calculations are additional to what would have occurred under business as usual. In other words, the forest management practices applied to the project site must exceed the baseline projection, as described in the preceding paragraph, thus leading to additional carbon stocks over time. For example, the management of the Bascom Pacific Forest exceeds the Option C rules through both the avoided depletion of standing stocks and through changes in forest management (by harvesting at a significantly lower rate than the rules allow, by improving understocked areas, and by expanding riparian buffer strips) that lead to increased carbon stocks on the property. As with an actual project, accrual of additional forest carbon stocks, and ultimately emission reductions, are assumed to happen over time. Therefore, emission reductions for the hypothetical Project are projected based on modeled results. Under the Protocols, these anticipated emission reductions would be monitored, measured, reported and independently verified over time to account for additional carbon stocks as they accrue.

Permanence: Permanence refers to the long-term duration of emission reductions. Achieving long term emissions reductions is a key international standard for carbon projects due to the long time it takes for CO_2 to be reabsorbed from the atmosphere (i.e., in its Fourth Assessment Report, the Intergovernmental Panel on Climate Change states "about 50% of a CO_2 increase will be removed from the atmosphere within 30 years, and a further 30% will be removed within a few centuries. The remaining 20% may stay in the atmosphere for many thousands of years" (IPCC 2007). Assuming the middle 30 percent cycles out in 200 years, about 41 percent of the original emission is still in the atmosphere after 100 years. These cycle times assume current sinks continue to function as they are now. It is possible that both oceanic and terrestrial sinks could absorb less CO_2 as the impacts of climate change intensify, thus these cycling times could lengthen (IPCC 2007).

This is an especially challenging area to adequately address in forest emissions reduction projects. Forests are naturally dynamic systems, with carbon flux reflecting growth and mortality, including varying degrees of natural disturbances. Insects and fire have naturally shaped forest ecosystems since time immemorial and resulting forest mortality, with associated carbon flux. The impacts of changing climate are affecting forest dynamics in ways we are only just beginning to observe and study. Forest management brings added elements such as intentional disturbance through logging, vegetation management, and site preparation for reforestation; as well as enhancements such as management to foster faster forest growth and stand re-establishment after harvest. Finally, forest owners and forest ownerships change over time and with these changes, forest management and carbon stocks often change. Forest ownership changes include both voluntary ones (e.g., the sale of a property) and involuntary ones (e.g., through the death or bankruptcy of the owner).

Yet, in spite of these challenges, it may be possible to craft a system whereby overall forest carbon emissions reductions at the project level can be defensibly considered long term, with a minimum life-time of 100 years. This is critical if forest based emissions reductions are to be considered equal to those achieved through the avoided combustion of fossil fuels, especially if the forest emissions reductions are being used as offsets to fossil fuel emissions under a mandatory regulatory scheme. In a GHG regulatory scheme that caps GHG emissions and allows both trading of allowances and the use of offsetting emissions reductions from uncapped sources such as forests, the project developer's promise to maintain a forest-based emissions reduction ton over 100 years allows a ton of CO_2 to be emitted into the atmosphere that wouldn't otherwise have been permitted.

Such a system should require project developers to assess the various risks to permanence, both anthropogenic and natural, and seek to mitigate them through legal instruments, required loss reserves of emissions reductions and forest management activities. The newly adopted version 3.0 of the Forest Project Protocol lays out such an approach. This scheme includes a 100-year contractual agreement between the Reserve and the project developer that would form the primary commitment mechanism, and could be further buttressed through a conservation easement (described further below). We note that in this Project Implementation Agreement

(PIA) the project developer agrees to maintain each year's accrued and verified emissions reduction for 100 years, implicitly extending the project lifetime for up to 199 years in total duration, or more than the duration of the contract with the Reserve. (See http://www.climateactionreserve.org/how/protocols/adopted/forest/current/.) In addition, each project is required to undertake a standardized risk assessment and, based on the verified results, contribute a percentage of each year's verified emissions reductions into a collective loss reserve or group insurance account administered by the Reserve called the Buffer Pool. As a remedy for actual tons lost to either avoidable or unavoidable reversals, such tons would be replaced with emissions reductions from those set aside in the Buffer Pool (for unavoidable or natural reversals) or as obtained from other projects as may be necessary in an avoidable reversal (due to, for instance, breach of the PIA or early project termination).

Version 2.1 of the Forest Protocols seek to address permanence by requiring all forest projects be secured with a perpetual conservation easement. While not as comprehensive, the approach outlined under version 3.0 of the Project Protocols, a conservation easement binds current and future landowners, and can be drafted to restrict land uses in such a fashion as to better secure the emissions reductions against losses from changes in ownership and management not only over 100 years, but in perpetuity. Given that around 40% of emitted CO_2 remains in the atmosphere 100 years later, there is considerable atmospheric benefit in a landowner's permanent commitment to maintaining additional carbon stores beyond the 100-year project lifetime required by the Reserve. As the PIA with the Reserve terminates at 100 years, and as the landowner may actually have on-going obligations to maintain emissions reductions beyond the 100-year project lifetime (i.e., for any ton accrued after year 1), a conservation easement provides added assurances. Further, conservation easements are enforceable against all future owners without advance assignment and, with proper drafting, can survive transfers at death or through bankruptcy or other forms of default, mitigating the risk of financial failure to lead to an emissions reductions reversal.

In the case studied here, the Bascom Pacific Forest is bound by a perpetual working forest conservation easement, which protects the forest project area from conversion to non-forest use and guides management practices to enhance overall forest carbon stocks. The easement is a voluntary legal instrument that was executed by the landowner and Pacific Forest Trust. The Trust, as easement grantee, is obligated to monitor and enforce the terms of the conservation easement, adding a layer of third party supervision and legally well-grounded enforcement rights to the Protocol specific but novel ones required in the PIA with the Reserve. In the event the landowner sells the property, the conservation easement will remain valid, as it is legally a part of the deed. Thus, no matter who owns the land, it will not be converted to non-forest use and the management impacts to it will be limited, as specified by the easement. Indeed, under the terms of the Bascom Pacific easement, the carbon stocks on the property are expected to increase to a certain minimum level and remain at (or exceed) that level. This is due to the requirement that management activities, in general, foster a significant increase in timber stocks from current levels to at least a specified stocking level. Once achieved, the landowner is committed to managing the forest in such as way as to help assure that at least this stocking level is sustained in perpetuity. As a result, the forest, and the climate benefits of the forest are permanently protected from risks associated with land use changes.

1.3 Application of Conservation Easements in the Context of Forest Carbon Projects

As noted above, under version 2.1 of the Forest Project Protocol, a conservation easement is required to mitigate risks to the permanence of emissions reductions generated by a project. While a new system has been established under version 3.0, conservation easements are optional for use associated with Improved Forest Management Projects (and still mandatory for Avoided Conversion projects). In calculating a project's Buffer Pool allocation, conservation easements are recognized as a valuable risk mitigation tool that results in a reduced allocation. As we expect that conservation easements will continue to be used in many of the Reserve's projects, this section examines their application in this context generally, with particular reference to the Bascom Pacific Forest project as an example.

Conservation easements have been in use in one form or another for about 100 years; although the modern era of conservation easement use began with formal recognition in the federal Internal Revenue Code in 1980 and a subsequent wave of conservation easement enabling statutes in states around the U.S. A conservation easement is a legal restriction that a landowner places on his or her property to define and limit the types of activities (e.g., development, forest management) that may take place there. It is drafted between the landowner (the "grantor") and the recipient organization (the "grantee") and must conform to enabling state legislation (e.g., see California Civ. Code § 815) and federal laws.

A conservation easement, generally speaking, is based on the principle of separating out one or more of various ownership rights (development, mineral, timber, etc.) and selling or giving those rights to a qualified third party (i.e., an appropriately constituted land trust or government agency). The underlying property and all the retained property rights are unaffected. As with a right of way or powerline easement or timber deed, a conservation easement becomes part of the title to the property and all future owners are subject to the easement's restrictions, even if the land is thereafter mortgaged, sold, transferred to heirs or subdivided; and existing mortgages or deeds of trust need to be subjected to the easement terms. In this way, the easement is permanently established for that property. Generally, conservation easements are donated or sold to the grantee entity, which then carries the responsibility to inspect the land periodically and enforce the restrictions. Enforcement provisions and remedies for breach are typically embedded in statute, and include the use of restraining orders or injunctive relief to stop damaging actions for requirement as well as the opportunity to require restoration of impaired conservation values, such as, for instance, lost carbon stores.

The specific rights that a property owner is restricting or retaining are spelled out in each easement document according to the agreement reached between the landowner and the recipient organization. Typically, with conservation easements certain development rights, such as construction, subdivision, timber harvesting or mining, are restricted to some degree so as to limit impacts on the land that may harm the conservation values that have been identified for protection. The grantee organization, such as the Pacific Forest Trust, receives these rights on the basis that they will ensure these rights are not exercised by the grantor through time.

A conservation easement drafted for the purposes of helping secure GHG emissions reductions needs to have certain key terms, including:

1. A specific recital identifying that the property is or will be enrolled in an emissions reduction project pursuant to the relevant standard (i.e., the Forest Protocol) and any relevant statutes.
2. Identification that the ability of the property to be conserved and managed to avoid emissions and/or reduce and store atmospheric CO_2 is a "conservation value" that provides significant public benefit consistent referenced public policy.
3. Inclusion of the same as one of the governing purposes of the conservation easement.
4. Specific restrictions on land use to achieve the purpose, depending on the property and the project activity, but which may include, for example, the prevention of the conversion of forest area to other cover types or uses; limitations on other forest disturbance, such as road building; limitations on the rate and extent of timber harvest over time; etc.

While conservation easements are of a perpetual term, they are not inflexible. Conservation easements can be amended with the consent of both parties to correct, clarify or change terms to reflect advances in knowledge or other changes in condition, provided that the overall conservation purposes are still achieved and the changes are consistent with public grant agreements and/or Internal Revenue Sservice regulations that may pertain. Conservation easements may also be extinguished under a court proceeding if the purpose for which the easement was created can no longer be achieved; or through government condemnation of the property as a whole.

1.3.1. Comparison of Conservation Easements to Other Deed Restrictions

A conservation easement is a form of deed restriction and some commentators have suggested other deed restrictions could be just as effective in securing carbon reductions on forest projects. Attorney Matthew Zinn of Shute Mihaly & Weinberger, LLP, considered this question for PFT and responded with a legal opinion dated April 15, 2009, arguing that conservation easements are superior to ordinary deed restrictions in their enduring enforceability through time, making them an appropriate instrument to buttress the permanence requirements of a forest carbon project:

> *"Deed restriction" is a generic term for a covenant or other servitude that limits the allowable uses of a property. For example, a deed restriction might limit future construction on the property to a single family home or specify portions of the property that cannot be developed.*
>
> *Deed restrictions will "run with the land," that is, they will automatically bind future owners of the restricted property, if they comply with a variety of formal legal requirements for the creation of servitudes. Most important in the present context is the requirement that the restrictions benefit a specific parcel or parcels of real property. As an example, consider a restriction that prohibits construction of any structure that would cast shade onto an adjoining property. The adjoining property owner could enforce the restriction against future owners of the restricted property because the restriction provides a clear benefit—access to sunlight—to the plaintiff's property. By contrast, restrictions with benefits "in gross"—benefits that do not accrue to a*

specific parcel or parcels—will not run with the land. See*, e.g.,* Marra v. Aetna Constr. Co.*, 15 Cal. 2d 375 (1940);* Chandler v. Smith*, 170 Cal. App. 2d 118 (1959);* Martin v. Ray*, 76 Cal. App. 2d 471 (1946); Cal. Civ. Code § 1468. For instance, in* Greater Middleton Ass'n v. Holmes Lumber Co.*, 222 Cal. App. 3d 980 (1990), the court held that a deed restriction prohibiting logging was enforceable by neighboring property owners against a subsequent owner because the restrictions identified "dominant and servient tenements," i.e., properties respectively benefited and burdened by the restriction.* Id. *at 992-94. The court rejected the defendants' argument that the restriction failed to benefit any property.* Id. *at 994.*

In response to this traditional limitation on the enforceability of deed restrictions, California and some other states legislatively established special categories of deed restrictions that will run with the land though they do not benefit identifiable parcels. Conservation easements are one category of such restrictions. See *Cal. Civ. Code § 815.1 (Conservation easement "means any limitation in a deed, will, or other instrument in the form of an easement, restriction, covenant, or condition, which is or has been executed by or on behalf of the owner of the land subject to such easement and is binding upon successive owners of such land."). The benefits of a conservation easement are almost always "in gross": they benefit the entity that holds the easement and the public generally, rather than a specific parcel of property.*

"Environmental covenants" represent another legislative exception to the rule. They are restrictions on the use of property contaminated with hazardous materials, such as a restriction that the property will not be used for residential or other uses that could bring people into contact with residual contamination. See *Cal. Civ. Code § 1471.*

Accordingly, one of the primary differences between a conservation easement and a run-of-the-mill deed restriction is the power of the former to bind successor landowners without a connection to a benefited property. Conservation easements are nevertheless subject to their own limitations, such as perpetual duration, the existence of a "purpose . . . to retain land predominantly in its natural, scenic, historical, agricultural, forested, or open-space condition," and the limited group of entities that may hold the easements. See *Cal. Civ. Code §§ 815.1, 815.2(b), 815.3. These limitations would prevent most ordinary deed restrictions from being considered de facto conservation easements.*

1.3.2. The Added Value of Easements to Landowners, Forest Ecosystems and Society

Conservation easements not only provide added insurance against the loss of GHG emissions reductions from the risks of changes in ownership or forest management; they also protect and enhance the important environmental co-benefits that forest projects can provide, such as habitat for rare or threatened species or natural communities, watershed values, and sustainable forestry. Further, they generally provide a means for individuals, families and businesses in rural communities to protect their natural resources and traditional land uses from depletion, urbanization, and wholesale development, while retaining private ownership and productive uses.

For the landowner, a conservation easement offers a means to protect the special attributes of a property without the need to relinquish the ownership and the use and enjoyment of the land.

In addition, the landowner gains the satisfaction of knowing that the land he or she values will be protected and preserved in perpetuity.

Moreover, conservation easements can bring financial returns to landowners, above and beyond those from the sale of emissions reductions. The conservation easement can provide near-term financial benefits, often gained in the year it is granted, while the sale of emissions reductions would typically provide an annual earnings stream that can defray on-going land stewardship costs associated with a landowner's conservation-based management commitments. A conservation easement that meets the standards of the Internal Revenue Code is deductible as a charitable contribution. Even easements not meeting the Internal Revenue Service standards may still provide tax benefits. For example, by reducing the size of a taxable estate a conservation easement may enable land to pass intact to future generations when it might otherwise have to be sold to pay estate taxes. On the other hand, a grantor may choose to sell a conservation easement and be paid with public funds, receiving immediate cash benefits as a result.

In either instance, the value of the easement is determined by comparing the value of the property prior to the easement grant and then again what it would be after factoring in the limitations set by the conservation easement. The easement value is then calculated as the difference between the "before" and "after" valuations. The primary driver to the value of a conservation easement on productive forestland is the degree to which development and timber harvest are restricted. Such appraisals must meet standards established for state and federal programs, as well as for charitable donations, the full description of which is beyond the scope of this paper. We note that interactions between conservation easement projects and emissions reductions projects and associated implications for their financial returns are only now emerging, as are the implications of the emerging carbon market for forestland valuation overall. As emissions reductions transactions and market data accumulate, appraisals will be required to analyze the impacts on conservation easement values.

With respect to the Bascom Pacific Forest, commercial timber owners in the state are at an increasing disadvantage as high cost producers in a global forest products market. As a response, many large owners are seeking to generally improve their company's financial performance or are leaving the state altogether. Combined with the often higher value of forest properties as rural residential and recreational real estate, this trend puts California's privately owned forests and their biological resources at risk. Conservation easements are a tool increasingly used in California and across the U.S. to bring added returns for landowners' sustainable forestry investments.

Conservation easements can be an effective, private, and low-cost means for the public to benefit from the protection of forestland for open space, wildlife habitat, ecological significance, responsible resource production and scenic enjoyment—all of which would be lost through unrestricted development. Conservation easements can both aid significantly in the protection of sensitive resources while supporting sustainable timber management that benefits the local and state economy. Unlike fee title acquisition by a governmental agency, the forestland stays on the property tax rolls and on-going land management costs remain with the landowner.

The conservation easement on the Bascom Pacific property provides numerous ecological and societal benefits that are cited in the document and form the argument for its public benefit conservation purposes. The conservation easement is written to help assure that:

- Productive timberland will be protected as such and stay in production.
- The land will stay in private ownership and current zoning, with no impact on property tax receipts.
- Wood will flow from the property to provide supplies to local mills and associated forest products businesses, helping sustain the local and regional timber economy in a time of decline.
- Scenic and recreational resources will be protected and enhanced, contributing to the growing tourism economy of northeastern California.
- Fish and wildlife resources will be protected and enhanced, contributing to the local economy through consumptive and non-consumptive enjoyment and to the ecological viability of the area.
- Current hunting and fishing access will be protected and improved.
- The detrimental environmental impacts of more development in the timberlands of McCloud region will be avoided, protecting resources and underpinning a more sustainable, mixed use economy.

Greater carbon sequestration will occur than the without-project scenario due to required changes to forest management that promote increases in biomass, on average, across the property and that such gains will be maintained in perpetuity, certainly well beyond the 100-year Reserve project lifetime.

1.3.3. Monitoring Requirements Associated with Conservation Easements

One means by which the permanence of the climate benefits associated with a project is ensured is through the easement grantee's monitoring of activities on or related to the project property and enforcing the terms of the conservation easement. By receiving an easement from the grantor, the grantee is authorized to enforce the specific terms of the easement on future use of the property. The grantee periodically monitors the property for compliance with the easement's restrictions and takes corrective action if its terms are violated. Enforcement can include legal action and restoration of the property. Procedures for correcting violations and rectifying damages are specified in the easement document itself.

In the case of the Bascom Pacific Conservation Easements, the properties are subject to both office-based and field-based monitoring activities. These activities include but are not limited to:

- Annual meeting to discuss plans for the coming year
- Office review of long term management plans and timber harvest plans, as well as site visits as needed to better understand such plans
- Confirmation with pertinent permitting agencies that the grantor has not submitted permit applications, unbeknownst to PFT, for activities that are prohibited or restricted by the conservation easement

- Review of Board of Equalization reports or similar documentation of timber harvest volumes
- Site inspection(s) to observe conditions and monitor for compliance with the easement restrictions. At least one site inspection will be made each year. However, during years in which active management is occurring, several site inspections may be required to ensure compliance is maintained.
- Annual review of aerial/satellite imagery (subject to availability of imagery) to remotely monitor portions of the property that were not directly visited during site inspection(s).

PFT produces monitoring reports following each site inspection. Such reports detail how the property was monitored, what observations were made during the visit, how such observations are related to the restrictions of the easement, and whether the grantor is in compliance with the easement. PFT also maintains records of correspondence related to the monitoring of the property, such as letters of approval for management plans that require review by PFT.

The monitoring and enforcement activities that a conservation easement holder is obligated to undertake help to secure the permanence of the climate benefits of a forest project and complement the landowner's measurement, reporting and verification requirements under the Protocols. In the case of Bascom Pacific Project, the monitoring and enforcement of the conservation easement, particularly the terms requiring forest management activities to achieve higher timber stocking levels than would be required under the Forest Practice Rules, ensure that the additional carbon stocks produced will be maintained in perpetuity, barring any natural catastrophic events.

2.0 Project Approach, or Methods

2.1 Description of Study Site

The Bascom Pacific Forest includes two tracts of commercial forestland in Siskiyou and Shasta Counties that are a subset of a larger ownership in area known as the Pondosa Timberlands. The River Tract consists of 4,859 acres and the Bear Tract consists of 4,344 acres. Both tracts are zoned for timber production and are composed primarily of mixed conifer forests. The average timber productivity rating on each tract is Site Class III. According to GIS data maintained by the landowner, approximately 8,326 acres of the property is in managed timberland, with about 480 acres in even-aged plantations; 282 acres are in areas managed for sensitive habitat, while approximately 500 acres are in watercourse or lake protection zones. Another 92 acres are in brushfields capable of supporting coniferous forest cover, while the remaining 31 acres are in non-forest cover types (Table 1). The closest community is McCloud. US Forest Service roads leading from Highway 89 provide access to both tracts. A map of the tracts is included below (Figure 1).

Table 1. Distribution of cover types on the Bascom Pacific Forest Project Site.

Cover Type	Acres
Managed Timberland	8,326
Uneven-aged	*7,846*
Even-aged	*480*
Sensitive Habitat	282

Watercourse/Lake Protection Zone	500
Brushfield	92
Non-Forest Cover	31

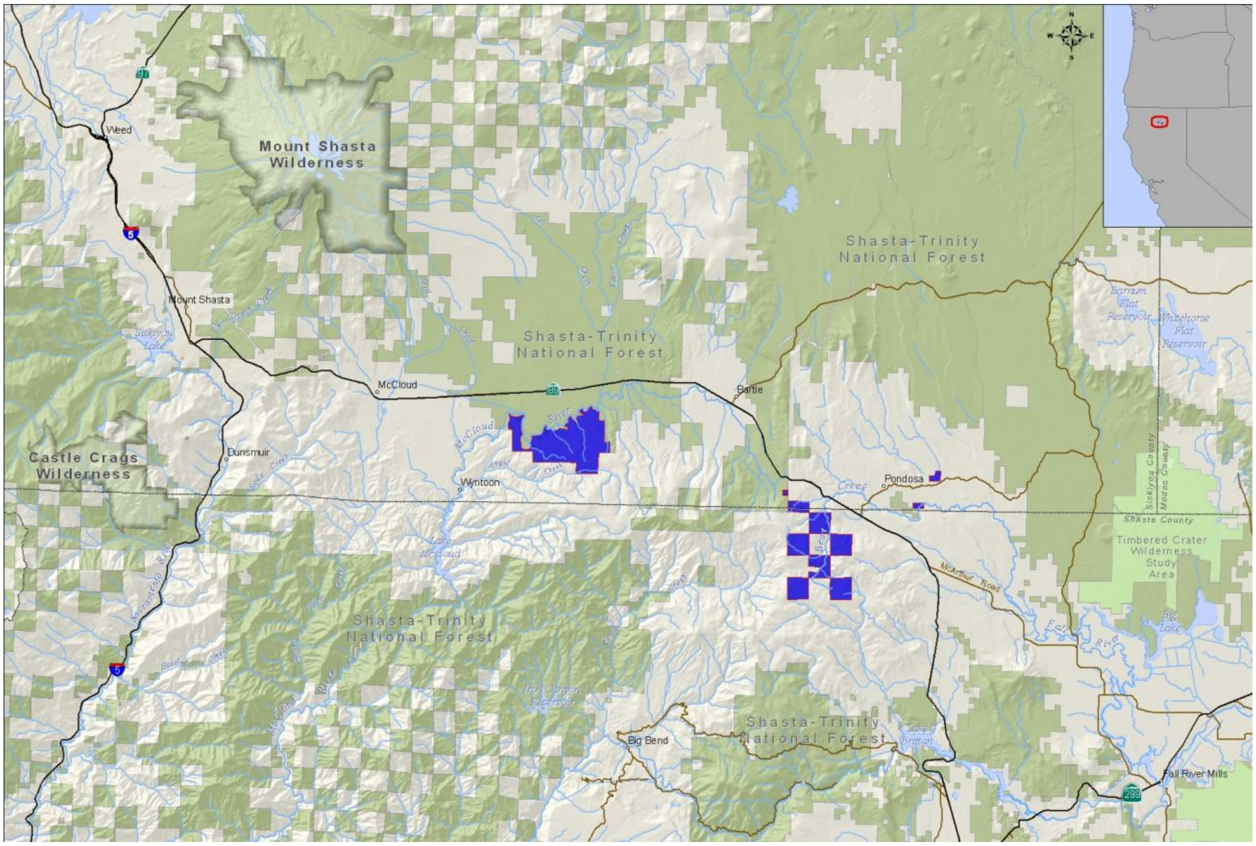

Figure 1. Bascom Pacific Forest project site (in dark blue).

2.2 Carbon Stocks Measurement Methodology

Initial carbon stocking was determined on the Bascom Pacific Forest at the initiation of project activities in 2006. A conventional commercial timber inventory performed prior to project initiation serves as the primary basis for evaluating baseline carbon stocks on the project site. Although performed prior to the development of this project, the timber inventory was nonetheless compliant with the measurement standards specified by the Forest Protocols for live trees and standing dead trees. A separate lying dead wood inventory was performed in 2007 in order to fulfill the requirement of the Forest Protocols to report carbon stocks in lying dead wood. Although lying dead wood data was gathered after the project initiation date, this pool is assumed to remain constant throughout the project lifetime. As such, the 2007 lying dead wood inventory was assumed to represent the same level of carbon stocks as were present at project initiation in 2006.

In 2007, the project site was sold to a new owner. Given the new landowner's interest in participating in the project, the change in ownership provided an opportunity to update the carbon inventory on the property. With the inventory update, improvements were made to the measurement methodology in order to increase efficiency and correct an error in the measurement standards applied to the sampling of lying dead wood in the initial inventory. All sampling for the inventory update was conducted during the fall of 2008. Determining the carbon stocks on the project site two years after the project was initiated provides the opportunity to analyze how well conditions on the ground match the conditions that were anticipated as a result of modeling performed under this study (see "Planned Activities to Increase Carbon Stores" below). Furthermore, the 2008 inventory update fulfills project monitoring obligations, ensuring that activities and conditions on the ground meet or exceed the standard of those outlined at project initiation.

Although conventional commercial timber inventories do not directly measure the biomass in all above-ground tree components, equations developed for general groups of species (Jenkins *et al*., 2003) can be applied to measurements that are taken in order to estimate the total above-ground biomass in a given tree. Similarly, below-ground biomass is estimated by applying a separate equation to the above-ground biomass values (Cairns *et al*., 1997). This equation is a generally accepted means of estimating below-ground biomass (e.g., Brown *et al*., 2004).

2.2.1 Purpose of the Inventory Efforts

The direct sampling efforts on the Bascom Pacific Forest were designed to generate inventory data that achieve the following:

6. Provide current estimates of the standing timber volume and biomass.
7. Provide current estimates of biomass in lying dead wood.
8. Support timber and habitat management activities.
9. In the case of the 2006 inventory, support projections of future timber resources and carbon stocks using the CACTOS growth model (Wensel *et al*. 1986; http://www.cnr.berkeley.edu/~wensel/ cactos/cactoss.htm).
10. In the case of the 2008 inventory update, monitor project activities and resulting changes to carbon stocks.

2.2.2 Live and Standing Dead Tree Inventory Methodology

Two cruise designs were used to generate a conventional commercial timber inventory on the Bascom Pacific Forest that served as the basis for estimating initial carbon stocks. From 2001-2004, inventory data were gathered using a cruise design that was based on variable radius plots and fixed radius subplots (1/250-acre) established on a 6.67 chain fixed grid with intermediate estimate plots. In the beginning half of 2005, inventory data were gathered using a cruise design that was similarly based on variable radius plots and fixed radius subplots (1/100-acre), but on a 5 chain fixed grid. As is typical practice for conventional timber inventories, temporary plots were employed for both cruise designs with the intention of generating inventory estimates at a single point in time. Although version 2.1 of the Forest Protocols requires plots to be "monumented in a way that allows them to be located and revisited for a period of 12 years," the plots installed on the Bascom Pacific Forest were not monumented in such a way that they would be revisited for additional measurements at a later point in time. This was due to the fact that the original intent of the timber inventory did not consider the requirements of the Forest Protocols. Nonetheless, the data collected on each of these plots met all other minimum sampling criteria and are discussed below. (For a comparison of inventory plot identification under both versions of the Protocols, see Section IX. below.)

A third cruise design was employed to estimate the carbon stocks in 2008. The cruise design was based on a uniform grid of variable radius plots and fixed radius subplots (1/100-acre) on a 5.0 chain fixed grid. Unlike the initial inventory, plots installed in 2008 were monumented to provide full compliance with the Forest Protocols.

Plot data gathered during inventory cruises were stored in a Microsoft Access database After stratifying plots into stand types, Wensel and Olson (1993) taper equations were used to calculate individual tree volumes within each plot. Additionally, individual tree biomass was computed using the above- and below-ground biomass equations provided in the Forest Project Protocols. Individual tree volume and biomass estimates were used to derive estimates of stand volumes and biomass. These stand-based estimates served as the basis for the summary inventory and biomass data for the Bascom Pacific Forest.

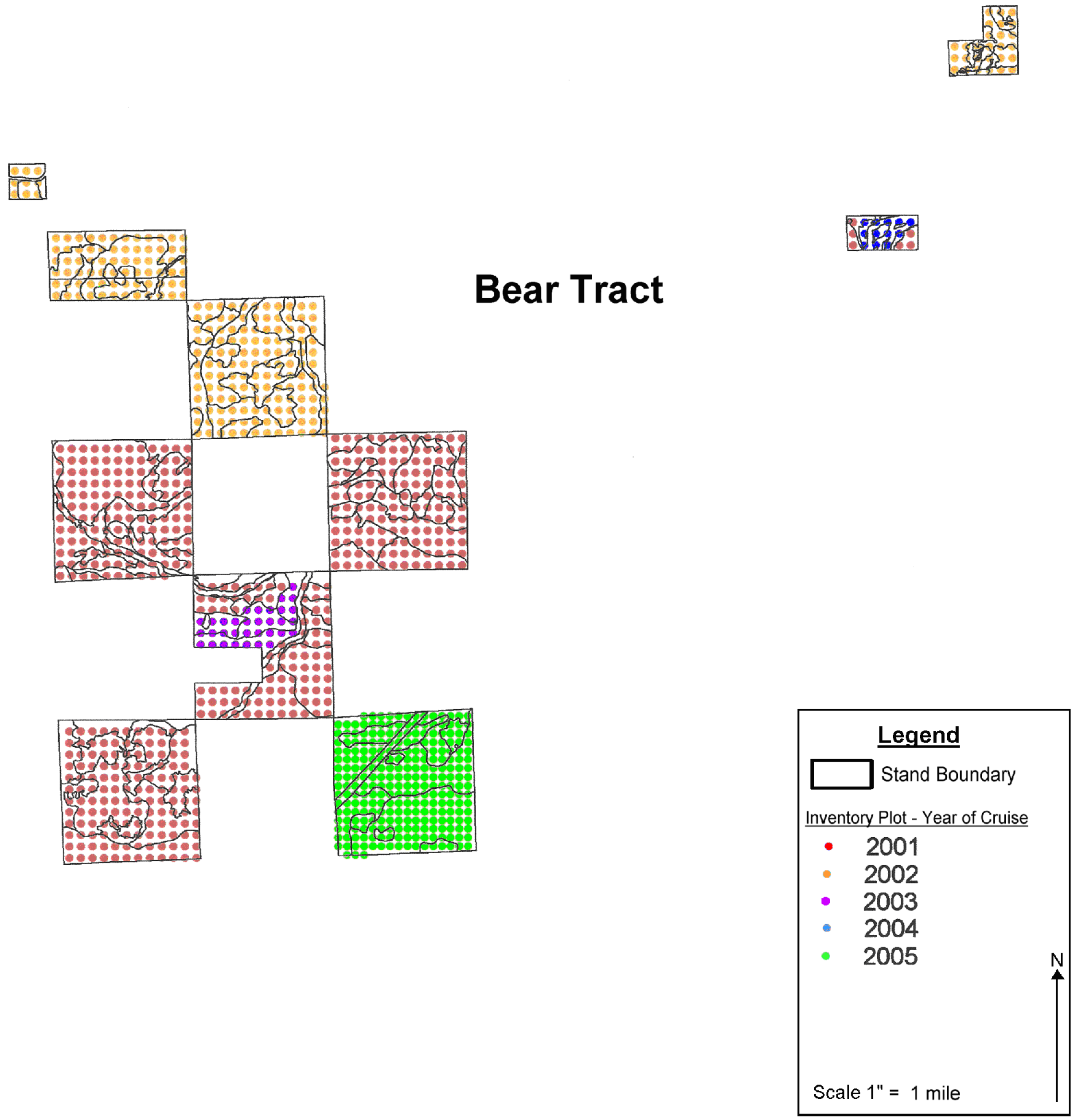

Figure 2. Plot map for live and standing dead tree inventory on the Bear Tract (2001-2005).

Plot Locations

2001-2005

Plots were located on a grid that was provided from a GIS for the property (Figures 2 and 3). From 2001-2004, primary plots were located on a grid pattern spaced 6.67 chains (440 feet) apart, resulting in one plot for every 4.4 acres. Secondary plots were located midway between (220 feet from) primary plots. In 2005, primary plots were located on a grid pattern spaced 5.0 chains (330 feet) apart, resulting in one plot for every 2.5 acres. Secondary plots were located midway between (165 feet from) primary plots. Plots were pre-numbered and displayed on maps supplied to the cruisers. Each plot number is a unique five digit number. Plots were located accurately in the field, using a combination of aerial photos and topographic maps for orienteering. For both cruise designs, the cruiser was free to choose his/her own direction of travel, but was instructed to use the plot numbers provided from the cruise map. Direction of travel from plot to plot was noted on each cruiser's field map.

If the plot center was not within the expected stand type, the cruiser documented the stand type it appeared to be in. For example, if the cruiser arrived at a plot location and determined that the vegetation condition was indicative of a condition in an adjacent stand, the cruiser would make a note and the plot would be assigned to the correct stand. Also, if the unbiased plot location turned out to be outside the property boundary with a high level of certainty, all that will be recorded is that the plot was located on the neighboring landowner. If there was any doubt of property ownership, the plot was recorded as normal.

The cruiser hung a long flag at eye level near the plot center and a short flag near ground level denoting the plot center. The plot number, date, cruiser's initials, and the direction of travel (e.g., 35 degrees Azimuth) were recorded on the flag at eye level. At each road crossing, one long flag was hung with the number of the next cruise plot and the direction of travel (135 degrees Azimuth), cruiser initials and date.

2008

Similar to the initial inventory, plots were located on a grid that was provided from a GIS for the property. Plots were located on a grid pattern spaced 5.0 chains (330 feet) apart, resulting in one plot for every 2.5 acres. Plots were pre-numbered and displayed on maps supplied to the cruisers. Plots were located accurately in the field using a map, compass, pacing, and GPS as necessary to establish plots within one chain of the desired location.

Plots installed in 2008 were monumented using 16-inch lengths of rebar driven into the ground so that only 3-4 inches of each was above ground. The above ground portions of rebar were painted day-glow orange to aid potential efforts to relocate plot centers in the future. Additionally, GPS coordinates of each plot center were recorded and witness tags were installed on nearby trees or other markers to help future relocation efforts. Each tag contained the plot number, true bearing, and slope distance to the center stake. Lastly, a 3-inch wide white band was painted around a witness tree at breast height.

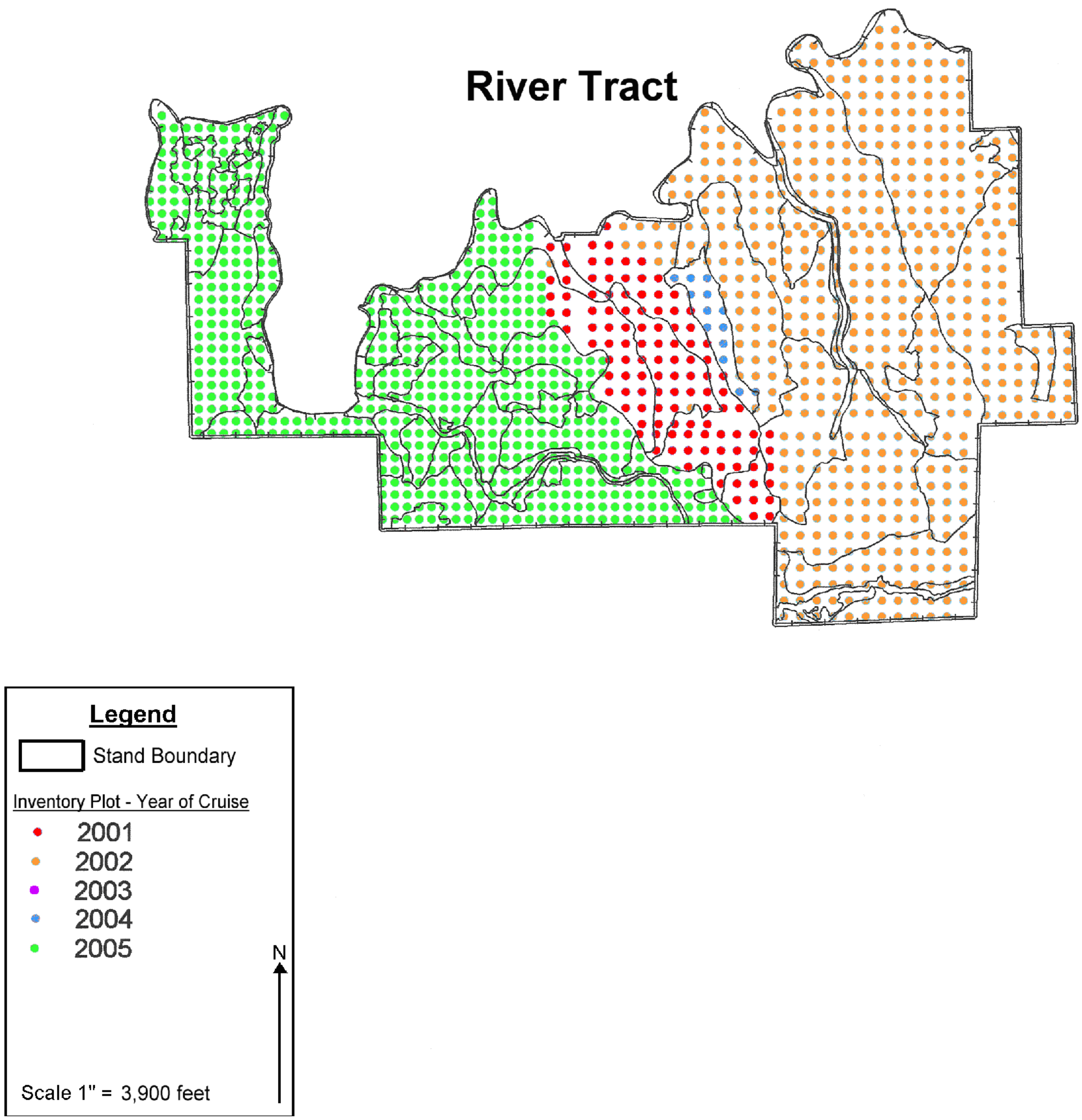

Figure 3. Plot map for live and standing dead tree inventory on the River Tract (2001-2005).

Plot Configurations and Measurement Standards

2001-2004

Each primary plot location consisted of a set of nested plots—a variable radius plot for larger trees and a fixed plot for smaller trees. Primary plots were taken using a variable radius plot with a 20 BAF prism. Trees 4.6 inches diameter at breast height (DBH) and larger were tallied for species and DBH to nearest inch. Snags greater than 10 inches DBH were measured for condition and DBH. A subsample of live measure trees also was taken at each primary plot using a prism with a BAF of 60, recording the species, DBH, total height and crown ratio. Measure trees that were snags were recorded for condition, DBH and total height.

A 1/250th acre regeneration plot (radius of 7.45 feet) was used to measure trees less than 4.6 inches DBH. Cruisers tallied up to ten of the most significant trees that were believed would become free to grow, recording species and DBH class for each tree.

Secondary plots were taken midway between primary plots using a variable radius plot with a 20 BAF. The cruiser tallied trees 4.6 inches DBH and larger by species only, and snags greater than 10 inches DBH by condition.

2005

Each plot location consisted of a set of nested plots—a variable radius plot for larger trees and a fixed plot for smaller trees. Volume plots were taken using a variable radius plot with a 20 BAF. Only trees 7.6 inches DBH and larger were tallied for species and DBH to the nearest inch. Snags greater than or equal to 12 inches DBH and 12 feet in height were measured for condition, DBH and height. A subsample of live measure trees was taken using a BAF of 60. These trees were measured for species, DBH, total height and crown ratio.

A 1/100th acre regeneration plot (radius of 11.78 feet) was used to measure trees less than 7.6 inches DBH. Cruisers tallied up to eight of the most significant trees that appeared to be free to grow. Trees were tallied by species, DBH class, height and live crown ratio. The frequency was recorded when a record represented more than one tree.

2008

Each plot location consisted of a set of nested plots—a variable radius plot for larger trees and a fixed plot for smaller trees. Volume plots were taken using a variable radius plot with a 20 BAF. Live and dead trees 4.6 inches DBH and larger were tallied for species and DBH to the nearest inch. For live trees, live crown was estimated to the nearest 10%. For dead trees, the decay condition was also recorded. Live and dead measure trees were taken using a BAF of 54. These trees were measured for species, DBH, total height and crown ratio.

A 1/100th acre regeneration plot (radius of 11.78 feet) was used to measure trees less than 4.6 inches DBH but above 0.6 inches DBH. The same information as was recorded for trees in volume plots was recorded for live, dead and measure trees in each regeneration plot.

Table 2 below shows a side-by-side comparison of the cruise designs and measurement standards used for the 2001-2004, 2005 and 2008 live and standing dead tree inventories.

Tolerance Standards

Check cruising was conducted on 10% of the plots in each year measurements were taken. The check cruise standards for specified data attributes developed to be consistent with the requirements of the Forest Protocol are listed in Table 3.

Table 2. Cruise designs and measurement standards for the 2001-2004, 2005 and 2008 inventories.

Inventory	**2001-2004**	**2005**	**2008**
Plot Spacing	6.67 chains (440 feet)	5.0 chains (330 feet)	5.0 chains (330 feet)
Plot Density	1 plot per 4.4 acres	1 plot per 2.5 acres	1 plot per 2.5 acres
Primary Plot			
Plot Type	Variable radius	Variable radius	Variable radius
Basal Area Factor	20	20	20
Data Recorded For Each Tallied Tree	- Species (“Hard” or “Soft” recorded for dead trees rather than species) - DBH (live trees >4.6”, dead trees >9.6”) by 1” class	- Species (“Hard” or “Soft” recorded for dead trees rather than species) - DBH (live trees >7.6”, dead trees >11.6”) by 1” class	- Species (including dead trees) - DBH (live and dead trees >4.6”) by 1” class - Decay class for dead trees (Harmon et al. 2007)
Measure Tree Subplot			
Plot Type	Variable radius	Variable radius	Variable radius
Basal Area Factor	60	60	54
Data Recorded For Each Tallied Tree	- Species (“Hard” or “Soft” recorded for dead trees rather than species) - DBH (live trees >4.6”, dead trees >9.6”) by 1” class - Height by 1’ class - Live crown ratio to nearest 10% class	- Species (“Hard” or “Soft” recorded for dead trees rather than species) - DBH (live trees >7.6”, dead trees >11.6”) by 0.1” class - Height by 1’ class - Live crown ratio to nearest 5% class	- Species (including dead trees) - DBH (live and dead trees >4.6”) by 1” class - Decay class for dead trees (Harmon et al. 2007) - Height by 1’ class - Live crown ratio to nearest 10% class
Regeneration Plot			
Plot Type	Fixed radius	Fixed radius	Fixed radius
Plot Size	1/250th acre (7.45 ft radius)	1/100th acre (11.70 ft radius)	1/100th acre (11.70 ft radius)
Data Recorded For Each Tallied Tree	- Species - DBH (<4.6”) by 1” class	- Species - DBH (<7.6”) by 1” class	- Species - DBH (<4.6”) by 1” class
Secondary Plot			
Plot Type	Variable radius	N/A	N/A
Basal Area Factor	60		
Data Recorded For Each Tallied Tree	Species		

Table 3. Tolerance standards applied to plots evaluated during check cruising.

Measurement Theme	Tolerance Standard
Species	Incorrect species cannot exceed 1 in 10 plots checked.
DBH	85% of the trees must match the actual tree DBH class. Of those trees that do not meet this standard, 90% must be within one DBH class. The remaining DBHs may vary by more than 2 classes.
Total Height	±10% of the actual tree height for heights up to 100 feet and ±10 feet for heights greater than 100 feet. Collectively, the recorded heights cannot demonstrate a significant bias compared to the actual heights.
Live Crown Ratio	85% of the trees must match the actual live crown ratio. Of those trees that do not meet this standard, 90% must be within a 10% class of the actual. The remaining can be up to 15% different than the actual.
Missed or Added Trees	The balance of missed or added trees cannot exceed ± 1 tree per 10 plots checked.

Stratification of Stands

Prior to sampling, both the Bear Tract and the River Tract were stratified into stands with relatively homogenous characteristics of species, size and density. Stratification was conducted using aerial photography and digitized for analysis in a GIS. Within the GIS, plot locations were overlaid with stand boundaries to determine the stand type assignment for each plot. Assigning a stand type to each plot allowed stand and volume tables to be developed and expanded by acreage in each stand type.

Data Recording, Storage and Organization

All cruise data was collected either on "Write-in-the Rain" cruise cards or on a handheld device or personal digital assistant (PDA). Data from the cards were entered into a Microsoft Access database form, whereas data from the handheld device or PDA was uploaded to a desktop computer on a consistent basis and hard copies printed.

Data gathered from these sources are maintained and managed within a dedicated database for the project site. This system allows the user to input data, fill in missing heights and live crown ratios, calculate volumes, perform harvest depletions, and project growth.

Data are organized in a hierarchical manner and are represented at the tree, plot and stand level. Individual tree measurements, as outlined above, from a given plot location comprise plot level data. Data from the plot level are then statistically expanded within a stand to create what is commonly referred to as a "tree list." This tree list is a statistical representation of the individual trees that comprise a given stand, based on the sample data.

Volume and Biomass Calculations

Both timber volume (in board feet or thousands of board feet) and biomass (in kilograms or tons) were calculated for individual trees represented in the stand tree lists. Timber volume and biomass may be derived from the same inventory data, yet one is not required to calculate the other. In other words, timber volume does not need to be calculated in order to determine the amount of biomass. Nor does biomass need to be calculated in order to determine the timber volume. Nonetheless, calculating both from the same inventory data serves several purposes. The equations and algorithms used to calculate timber volume have been thoroughly tested and, generally, are a part of common practice in the timber industry in the vicinity of the project. Thus, timber volume calculations have a relatively high degree of certainty associated with them. On the other hand, biomass equations such as those used in this study have not received the same amount of use, especially in the way they are applied here. However, since the same inventory data is used to calculate both timber volume and biomass and since there is a logical relationship between timber volume and biomass (i.e. an increase in timber volume means there is a similar increase in biomass), it is reasonable to use timber volume calculations for quality assurance purposes to ascertain whether biomass calculations seem as though they are being applied properly. This is particularly important when it comes to modeling future biomass stocks, as is described later in this report.

The equations provided by version 2.1 of the Forest Project Protocols, indicated in Table 4, were used to calculate the above- and below-ground biomass pools. Above-ground biomass was calculated for individual trees within the tree list for each stand. Individual above-ground biomass was then converted to a per hectare density value in order to calculate below-ground biomass density. Combining the above-ground and below-ground values produced a total tree biomass density value. In order to convert this value to carbon tons per acre, biomass values are multiplied by 0.5 to convert from biomass to carbon and by 0.001 to convert from kilograms to metric tons, as specified by the Forest Project Protocols, and divided by 2.471 to convert from per hectare to per acre.

Table 4. Equations for tree species biomass estimates.

Above-Ground		
Species	**Biomass (kg) Equation**	**Limitations**
Coast Redwood Giant Sequoia Incense Cedar	*Exp*(-2.0336 + 2.2592 x ln DBH)	Max DBH = 250 cm
Douglas Fir	*Exp*(-2.2034 + 2.4435 x ln DBH)	Max DBH = 210 cm
Pinus spp.	*Exp*(-2.5356 + 2.4349 x ln DBH)	Max DBH = 180 cm
Abies spp.	*Exp*(-2.5384 + 2.4814 x ln DBH)	Max DBH = 230 cm
Quercus spp.	*Exp*(-2.0127 + 2.4342 x ln DBH)	Max DBH = 73 cm
Tanoak	*Exp*(-2.4800 + 2.4835 x ln DBH)	Max DBH = 56 cm
Below-Ground		
BBD = *Exp*(-0.7747 + 0.8836 x ln ABD)		

- Above-Ground Biomass Equations originally published by Jenkins *et al.* (2003)
- Below-Ground Biomass Equation originally published by Cairns *et al.* (1997)
- DBH = diameter at breast height in centimeters
- BBD = below-ground biomass density (tons/hectare)
- ABD = above-ground biomass density (tons/hectare)

Inventory Updating

All inventory data recorded for the initial inventory were updated at the end of each year, through the project start at the end of 2006, to reflect harvest and growth. Harvest volumes from bureau scale summaries were depleted from the inventory within database for the 2001 through 2005 period prior to project initiation in 2006. Depletions were taken only from stands in which harvest occurred and were implemented in such a fashion as to accurately reflect the harvest by species and DBH classes. Clearcuts and shelterwood removals were completely or nearly completely depleted, respectively. Depletions were taken from the beginning of the year inventory. Once depletions were completed in a given year, a growth simulation was conducted for one growing season.

Growth estimates were conducted using the California Conifer Timber Output Simulator (CACTOS), version 6.3 (Wensel *et al.* 1986; http://www.cnr.berkeley.edu/~wensel/cactos/cactoss.htm). Growth models within CACTOS were adjusted and validated based on permanent plot data from this and adjacent ownerships. Fifteen years of growth data and stem analysis plots were used in developing and improving the modeling effort. CACTOS has proven to be a reliable growth estimator for managed stands of low to moderate stand densities. CACTOS may overestimate growth in stands that do not receive intermediate treatments. An ongoing inventory process will help to reduce the effects of an over-reliance on the growth model. The results from this study reflect growth estimates that are well within the parameters of the model.

Since the initial inventory data were collected over a number of years, stands inventoried prior to the start of project activity were grown out so that estimates of volume and biomass for baseline conditions in all stands were based on the same point in time, i.e. the start of project activities in 2006.

Statistical Calculations

The Forest Project Protocols require that project submitters address the level of statistical confidence they have in the estimates of carbon pools that are reported. Only projects for which the sampling error is within 20% of the estimate of the mean at the 90% confidence level *for all pools combined* are eligible to be registered with the Reserve. If the standard error is below 20% but above 5%, a deduction is applied to the estimated carbon stocks so that the amount of stocks eventually registered account for the degree of uncertainty associated with the inventory.

The mean carbon stock estimates from the stratified sampling methods outlined above served as the basis for evaluating the standard error at the 90% confidence level. Only stands that were sampled and, thus, have statistical information were used in the calculations. The standard error of the mean carbon tons per acre for each stand was determined from the sample variance between sample plots within a given stand. The standard error for individual stands were then weighted by stand acreage and combined to determine the cumulative standard error at the 90% confidence level for each tract.

2.2.3 Lying Dead Wood Inventory Methodology

The purpose of the lying dead wood inventory was to determine the amount of lying dead wood (down woody debris) on the Bascom Pacific Forest, using methods that are consistent with the Forest Project Protocols for estimating carbon in lying dead wood. The project site was first sampled for lying dead wood in 2007. After conducting this initial inventory, it was determined that the minimum specification for the measurement of the diameter of lying dead wood pieces did not meet the measurement standards of the Protocols. The Protocols specify that the minimum average diameter to be measured is 6 inches for pieces at least 10 feet long. The measurement specification for the 2007 inventory was a minimum diameter of 10 inches at the large end of the piece. As a result, a variety of piece sizes likely were not captured by sampling though they should have been. For example, a 10 foot long piece that has a large end diameter of 9 inches and a small end diameter of 5 inches (thus, an average diameter of 7 inches) would not be included as part of the inventory. Omitting such pieces would lead to an underestimation of lying dead wood stocks. To address this initial error, the lying dead wood pool was resampled in 2008 along with the resampling of standing live and dead trees, with the diameter specification adjusted to conform to the measurement standards of the Forest Protocols.

Plot Spacing, Configuration and Locations

The method chosen to inventory lying dead wood for the project site in 2007 was a fixed area plot design. To maximize data collection efficiency, long rectangular plots measuring 5 chains (330 feet) long by 0.5 chains (33 feet) wide, placed end to end across an entire section (where possible) were measured. This design allowed the cruiser to walk the center line of the plot using a string box to record distance, while estimating the plot perimeter location at 16.5 feet either side. Layout of the plots involved placing a string of fourteen (14) consecutive plots in cardinal directions, separated by 10 chains between strings of plots, in each ½ section of ownership. This design allowed the cruiser to travel out on one line and back on the adjacent line where possible. Pairs of strings were separated by 30 chains. Full sections had 56 plots, ½ sections had 28 plots, ¼ sections had 14 plots, and 40 acre blocks had at least 3 plots. Sampling intensity averaged 1 plot per 11.4 acres, or 2.2%. See Figures 4 and 5 below for plot locations in 2007.

Sampling of lying dead wood in 2008 was based on three transects radiating from the same plot centers used to sample standing live and dead trees (see *Plot Locations* in *2.2.2. Live and Standing Dead Tree Inventory Methodology* above). Transects were 22 feet in horizontal distance and radiated from the each plot center at true bearings of 360°, 120° and 240°.

Measurement Specifications

<u>2007</u>

The minimum specification for measurement of a piece of lying dead wood was:

1. ≥10 inches diameter inside bark at the large end
2. ≥10 feet long within the plot
3. >50% of the log diameter is above ground.

For each lying dead wood piece, the following items were recorded:

1. Plot number
2. Average diameter inside bark of the piece in inches measured at the midpoint of its length using a biltmore stick
3. Length of the piece within the plot boundary in feet using a logger's tape
4. Decay status (hard, intermediate or soft).

Decay status was determined by kicking with the boot. A piece was considered hard if the kick bounced off without leaving a mark, intermediate if the kick left a dent in the log, and soft if the kick penetrated the log.

2008

A piece of lying dead wood was tallied if the transect crossed its long axis and met the following minimum specifications:

1. ≥3 inches diameter outside bark where the transect crosses the piece
2. ≥1 foot long
3. >50% of the log diameter is above ground.
4. Not in decay classes 4 or 5 (see below).

For each lying dead wood piece, the following items were recorded:

1. Piece Number, counting along each transect, starting at plot center.
2. Species, if discernable.
    - OH for Hardwood or OC for Conifer if species is not apparent.
    - Record 'NT' for any transect without any pieces tallied.
3. Decay class (Harmon *et al*. 2007):
    - Tally only pieces in classes 1 through 3. Classes 4 and 5 are considered part of the forest floor; a carbon pool not tracked in this analysis. .
    - 1: Leaves still attached and all having intact bark, fine twigs, and branches. Logs originating from cutting may not have branches and twigs, but the cuts appear fresh and have not yet turned gray due to sun bleaching.
    - 2: Starting to decompose, leaves largely are absent, and many of the fine twigs have fallen off the larger branches. Bark is typically loose, but only starting to fall off the log. For all species, there is evidence the surface layers of the wood are decomposing, but the inner, central region of the wood is undecayed unless previously infected with heart rots. For logs originating from cutting, the ends are gray from sun bleaching.
    - 3: Only a few large branches remaining, often in the form of stubs, the bark is falling off in large patches, and evidence of sloughing of sapwood is also evident. The outer wood is easily crushed by hand, although the inner portions can appear completely sound. Are able to support their own weight along most of their length. For certain genera with decay resistant heartwoods, such as *Calocedrus*, *Quercus*, and *Thuja*, decayed sapwood may fall off to the extent that relatively sound heartwood may form the outer surface.
    - 4: Logs cannot support their own weight and most of their length conforms to the contours of the underlying ground. Although circular cross-sections can remain, much of the log forms an elliptical cross-section. Branches, if present, are short stubs, which move when pulled. This indicates decay has spread to the innermost portions of the log and has weakened the wood considerably. Bark, if present, is in small loose patches on the log and found in piles alongside or under the log. In the

case of the genera *Betula* and *Prunus*, the bark loosely surrounds the inner, highly decomposed wood.

- 5: The most decomposed, of elliptical shape (the long axis is often many times that of the short axis), and are beginning to be incorporated into the forest floor. The wood is extremely decayed, usually in the form of cubical brown rot that can be easily crushed by hand. Bark is not evident from the surface (except for the genera *Betula* and *Prunus*) and in most cases underlies the extremely decomposed wood.

4. Diameter outside bark, perpendicular to the long axis where the transect crosses the piece.
5. Length, in feet.

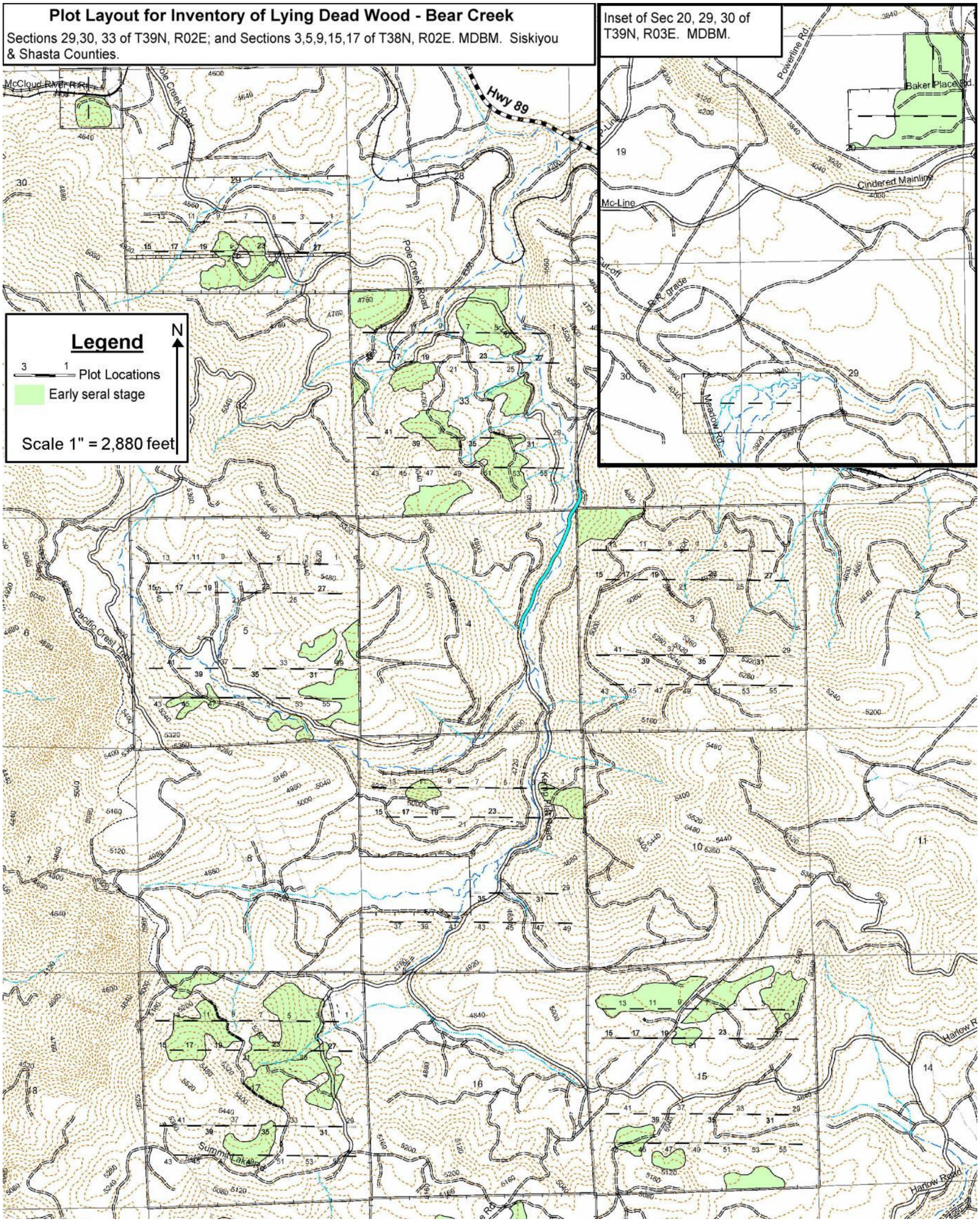

Figure 4. Plot map for lying dead wood inventory on the Bear Tract (2007).

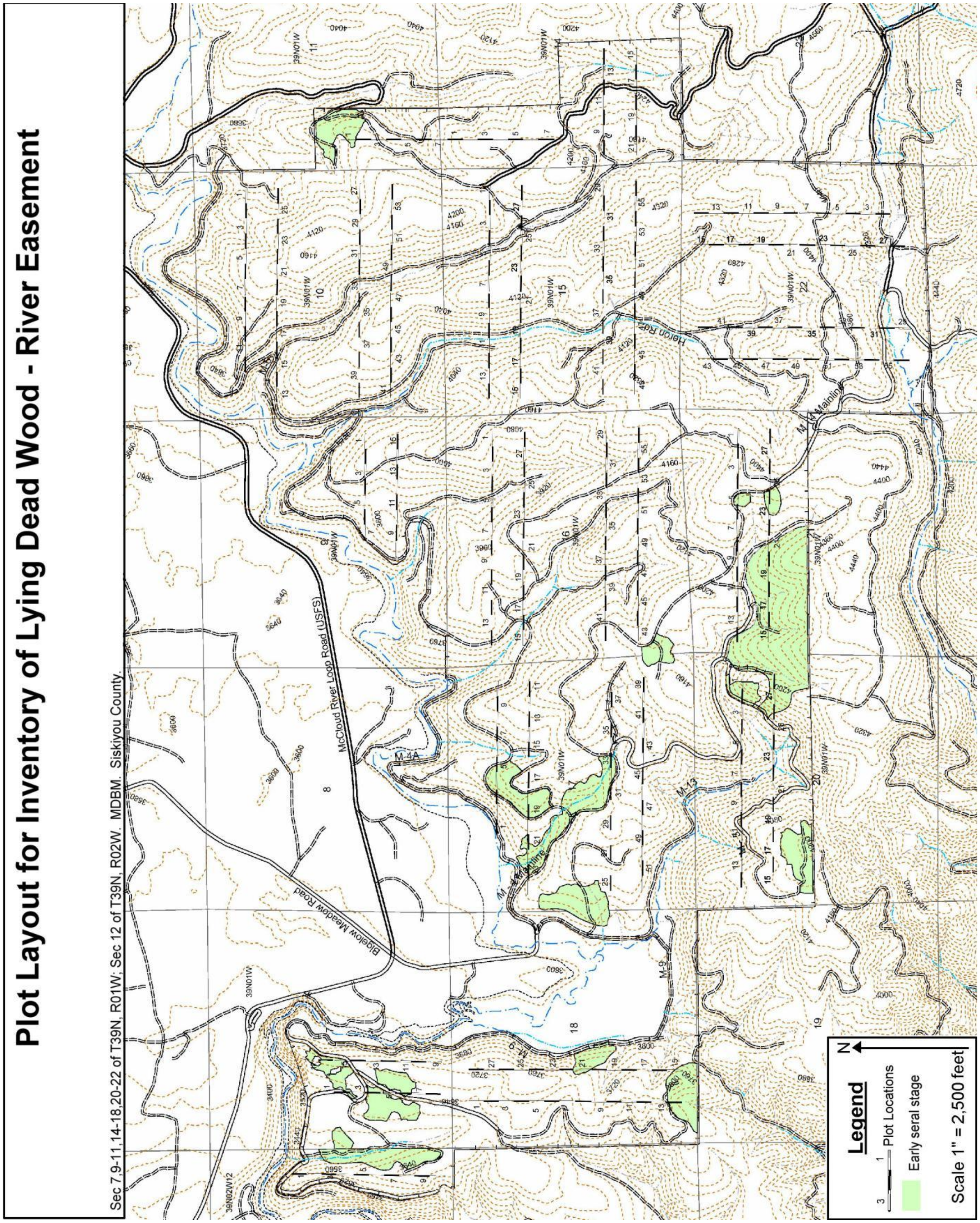

Figure 5. Plot map for lying dead wood inventory on the Bear Tract (2007).

Data Storage and Volume Calculations

Data were entered into a Microsoft Access database. Cubic foot volumes were calculated for each piece using the formula Cubic Feet (ft3) = 0.005454 x (Diameter in inches)^2 x Length (ft). Volumes of lying dead wood were determined by section, and tract. Conversion factors (Tables 5 and 6) were used to convert cubic volume by decay status to weight in metric tons for the 2007 and 2008 lying dead wood inventories.

The amount of carbon was determined by multiplying the lying dead wood biomass (metric tons) by 0.50 as defined in Forest Project Protocol. Plot-based values were then expanded to determine the overall lying dead wood carbon stocks on the Bascom Pacific Forest. The mean carbon stock estimates served as the basis for statistical analysis at the 90% confidence level. Standard error of the mean carbon per acre for the project site was determined from the sample variance between plots in 2007, and between strata in 2008.

Table 5. Dead wood densities (from Brown *et al.*, 2004) used to convert cubic volume to biomass dry weight for 2007 inventory.

Decay Status	Sierran Mixed Conifer Species Dead Wood Density (g/cm^3)**	Density in metric tons per cubic feet (t/ft^3)
Hard	0.50	0.0142
Intermediate	0.32	0.0091
Soft	0.17	0.0048

Table 6. Dead wood absolute densities used to convert cubic volume to biomass dry weight for 2008 inventory.

Decay Class	1	2	3	4	5
Species	*Absolute Density*				
Black Oak	0.611	0.450	0.382	0.241	0.248
Black Cottonwood	0.370	0.422	0.300	0.160	0.110
Douglas-fir	0.386	0.308	0.152	0.123	0.148
Incense Cedar	0.425	0.269	0.231	0.156	0.143
Jeffrey Pine	0.365	0.358	0.217	0.205	0.171
Knobcone Pine	0.368	0.324	0.273	0.169	0.171
Lodgepole Pine	0.378	0.367	0.276	0.169	0.164
Other Conifer	0.340	0.277	0.121	0.138	0.122
Other Hardwood	0.533	0.422	0.325	0.212	0.158
Pacific dogwood	0.533	0.422	0.325	0.212	0.158
Ponderosa Pine	0.338	0.333	0.330	0.129	0.188
Quaking Aspen	0.353	0.422	0.299	0.160	0.110
Red Alder	0.386	0.326	0.197	0.108	0.117
Red Fir	0.478	0.378	0.150	0.143	0.084
Sugar Pine	0.369	0.267	0.155	0.122	0.171
White Fir	0.340	0.277	0.121	0.138	0.122
Willow	0.533	0.422	0.325	0.212	0.158

3.0 Carbon Inventory Results

Summaries for the conventional timber inventory and the carbon inventory have been compiled for the project area for the project initiation year of 2006, as well as for project monitoring that took place in 2008. Summaries at the project level provide the total and per acre volume and carbon stocks by species, as well as total volume and carbon stocks by diameter at breast height for each species.

3.1 Standing Timber Volume and Carbon Stocks

Total net volume, in thousands of board feet (MBF), and carbon stocks, in metric tons, by species for each tract and the project area are shown in Table 7.

Tables 8 and 9 display the timber volume and standing carbon stocks by diameter at breast height (DBH) and species for the project site in 2006 and 2008, respectively.

Table 7. Total net timber volume and standing above-ground live and dead carbon stocks for the project site at project initiation in 2006 and mid-project in 2008.

	Species	Total Volume (MBF*)	Volume Density (MBF/acre)	Above-Ground Carbon (metric tons)	Above-Ground Carbon Density (metric tons/acre)
2006	Ponderosa Pine	6,638	0.7	27,267	3.0
	Sugar Pine	4,357	0.5	9,931	1.1
	Douglas-Fir	16,733	1.8	51,697	5.6
	True Firs	60,559	6.6	158,555	17.2
	Incense Cedar	1,879	0.2	13,954	1.5
	Other Conifers	216	0.0	909	0.1
	Hardwoods	1,524	0.2	30,603	3.3
	Snags	*n/a*	*n/a*	*3,142*	0.3
	Total	**91,906**	**10.0**	**296,058**	**32.2**
2008	Ponderosa Pine	11,382	1.3	36,707	4.0
	Sugar Pine	4,951	0.5	10,632	1.2
	Douglas Fir	22,179	2.4	63,760	7.0
	True Firs	70,392	7.8	176,243	19.4
	Incense Cedar	3,017	0.3	15,616	1.7
	Other Conifers	708	0.1	1,521	0.2
	Hardwoods	426	0.0	18,002	2.0
	Snags	*n/a*	*n/a*	*8,275*	0.9
	Total	**113,055**	**12.5**	**330,756**	**36.4**

** Total net MBF (Scribner Short Log Scale - 6” Top)*

Table 8. Total net timber volume (MBF) and standing carbon stocks (metric tons) by DBH class and species for the Bascom Pacific Forest in 2006. Carbon stocks account for above-ground biomass only.

DBH Class	Ponderosa Pine		Sugar Pine		Douglas-Fir		True Firs		Incense Cedar		Other Conifers		Hardwoods		Snags		Total	
	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C
1	-	54	-	6	-	62	-	241	-	209	-	2	-	49			-	624
2	-	84	-	11	-	171	-	707	-	171	-	6	-	233			-	1,384
3	-	78	-	8	-	123	-	471	-	175	-	9	-	1,283			-	2,146
4	-	485	-	19	-	533	-	1,003	-	516	-	8	-	4,309			-	6,873
5	-	459	-	19	-	421	-	1,464	-	538	-	-	-	3,723	n/a	21	-	6,644
6	-	947	-	111	-	539	-	2,601	-	649	-	62	-	5,399	n/a	18	-	10,327
7	-	1,276	-	119	-	817	-	2,870	-	738	-	15	-	2,483	n/a	60	-	8,379
8	3	2,970	-	62	26	1,110	130	4,843	-	730			11	1,693	n/a	55	171	11,463
9	202	2,113	8	100	110	1,055	604	4,873	-	915	6	130	25	1,033	n/a	18	954	10,237
10	385	2,657	20	156	263	1,817	1,184	7,047	16	902	2	22	60	1,340	n/a	105	1,930	14,046
11	382	2,243	41	238	311	1,512	1,324	6,215	81	896	13	90	59	849	n/a	120	2,212	12,164
12	447	2,057	70	316	418	1,947	2,330	8,479	109	980	29	109	136	1,461	n/a	259	3,537	15,609
13	397	1,397	108	401	493	1,968	2,439	7,842	98	815	34	133	50	440	n/a	167	3,620	13,163
14	449	1,460	86	260	805	2,885	3,182	9,270	138	885	9	30	101	757	n/a	250	4,770	15,798
15	283	849	105	315	749	2,445	2,632	6,973	68	383	16	50	115	766	n/a	192	3,967	11,973
16	451	1,210	196	599	1,013	3,206	4,915	12,231	164	778	5	13	182	1,106	n/a	303	6,926	19,447
17	463	1,010	101	295	944	2,777	3,590	8,361	65	262	14	47	118	654	n/a	183	5,294	13,590
18	536	1,172	260	602	1,149	3,271	5,278	11,628	145	576	20	41	101	528	n/a	223	7,488	18,041
19	270	551	219	490	1,088	2,922	3,849	8,173	119	430	4	11	98	481	n/a	101	5,647	13,160
20	443	909	357	786	1,211	3,185	4,984	10,125	154	497	12	25	62	294	n/a	171	7,223	15,993
21	255	459	249	547	1,138	2,864	3,214	6,267	120	369	26	56	77	349	n/a	89	5,078	11,000
22	520	1,003	379	729	1,037	2,563	4,463	8,445	90	273	11	20	74	321	n/a	110	6,574	13,465
23	160	300	209	433	905	2,223	3,047	5,612	76	218	17	30	58	246	n/a	46	4,472	9,107
24	327	522	245	453	897	2,158	3,408	6,259	84	248			40	163	n/a	42	5,000	9,846
25	145	253	187	350	754	1,760	2,846	4,989	85	228			34	136	n/a	16	4,052	7,732
26	91	146	153	271	824	1,792	2,193	3,725	70	165			19	76	n/a	43	3,350	6,219
27	106	161	286	504	577	1,293	1,101	1,829	57	134			5	20	n/a	15	2,133	3,956
28	159	219	254	412	509	1,110	1,258	2,068	39	83			34	127	n/a	51	2,252	4,069
29	37	46	141	233	352	757	797	1,263	5	12			6	24			1,339	2,335
30	68	90	238	374	405	892	705	1,099	12	26			14	53	n/a	85	1,443	2,618
31	3	4	193	321	157	306	418	620	11	23			19	75			801	1,349
32	36	52	106	171	159	335	197	291	5	10					n/a	53	502	912
33	-	-	64	96	82	171	56	84					6	28	n/a	9	209	389
34	20	24	45	65	96	191	182	260	8	12			11	55	n/a	28	361	635
35	3	4	11	18	138	267	56	98	18	33					n/a	23	227	443
36	1	1			33	70	38	49	20	39					n/a	26	91	185
37					11	26	30	41					4	24			45	91
38					19	40							4	23	n/a	35	22	98
39			26	41	60	113			3	5							89	158
40							81	102							n/a	63	81	165
41							27	38									27	38
42															n/a	9	n/a	9
47															n/a	9	n/a	9
48															n/a	55	n/a	55
49															n/a	11	n/a	11
57									21	31							21	31
60															n/a	14	n/a	14
64															n/a	12	n/a	12
70															n/a	34	n/a	34
80															n/a	13	n/a	13
Total	**6,638**	**27,267**	**4,357**	**9,931**	**16,733**	**51,697**	**60,559**	**158,555**	**1,879**	**13,953**	**216**	**909**	**1,524**	**30,603**	**n/a**	**3,142**	**91,906**	**296,058**

Table 9. Total net timber volume (MBF) and standing carbon stocks (metric tons) by DBH class and species for the Bascom Pacific Forest in 2008. Carbon stocks account for above-ground biomass only.

DBH	Ponderosa Pine		Sugar Pine		Douglas Fir		True Firs		Incense Cedar		Other Conifers		Hardwoods		Snags		Total	
Class	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C	MBF	C
1	-	12	-	2	-	25	-	120	-	77	-	5	-	447	-	39	-	727
2	-	44	-	3	-	129	-	422	-	238	-	3	-	955	-	170	-	1,963
3	-	160	-	7	-	224	-	917	-	282	-	15	-	1,076	-	274	-	2,957
4	-	303	-	-	-	348	-	1,337	-	541	-	-	-	1,058	-	383	-	3,970
5	-	247	-	-	-	769	-	1,875	-	422	-	-	-	709	-	401	-	4,423
6	-	1,008	-	78	-	529	-	3,169	-	569	-	45	-	1,194	-	317	-	6,909
7	-	1,847	-	-	-	446	-	3,405	-	530	-	-	-	905	-	617	-	7,750
8	-	1,864	-	79	-	1,829	30	4,965	-	646	-	-	14	611	n/a	381	44	10,375
9	534	2,769	12	92	163	980	1,030	5,443	-	992	50	202	28	924	n/a	450	1,817	11,853
10	866	3,933	18	93	410	2,000	1,467	6,031	-	599			23	572	n/a	370	2,784	13,599
11	658	2,851	35	149	419	1,621	1,586	6,298	156	943	81	214	19	909	n/a	302	2,954	13,287
12	652	2,838	47	208	577	2,215	2,335	7,583	121	589	63	115	20	745	n/a	110	3,815	14,403
13	939	2,934	119	431	658	2,452	2,983	8,583	198	1,155	25	56	26	721	n/a	395	4,949	16,729
14	1,033	2,731	191	548	624	1,956	3,232	9,505	211	1,306	7	58	23	566	n/a	673	5,322	17,343
15	707	1,942	95	283	1,198	3,441	3,398	8,674	148	629	140	220	29	760	n/a	432	5,715	16,380
16	634	1,547	206	575	1,009	3,034	4,213	10,097	154	498	70	138	31	894	n/a	440	6,316	17,222
17	540	1,137	213	549	1,296	3,953	4,719	10,731	158	598	76	133	22	579	n/a	441	7,024	18,121
18	510	1,143	161	372	1,076	2,848	5,593	12,668	204	682	109	185	23	526	n/a	289	7,675	18,714
19	329	593	472	1,073	1,964	4,996	5,084	10,647	221	724	42	66	31	603	n/a	295	8,143	18,996
20	572	1,185	233	529	1,164	2,928	5,144	10,384	148	442			5	281	n/a	275	7,266	16,024
21	437	834	357	744	1,090	2,869	4,309	8,725	170	460			22	532	n/a	159	6,385	14,322
22	589	1,040	348	632	1,370	3,642	4,627	8,992	132	355			23	534	n/a	116	7,090	15,312
23	489	775	414	776	1,071	2,659	3,917	7,142	193	511			13	235	n/a	300	6,096	12,399
24	302	500	272	522	1,447	3,245	3,712	6,629	151	392			6	123	n/a	82	5,889	11,492
25	261	427	230	425	1,354	3,013	3,124	5,284	221	529	45	67	19	383	n/a	80	5,254	10,208
26	217	368	415	719	1,072	2,504	2,803	4,847	125	299			27	406			4,658	9,142
27	402	628	303	520	1,104	2,390	2,097	3,664	58	131							3,964	7,332
28	145	229	186	317	663	1,488	1,264	2,135	85	172			15	263	n/a	175	2,357	4,778
29	112	153	257	355	694	1,480	1,060	1,727	35	69					n/a	7	2,159	3,791
30	53	80	50	79	815	1,769	870	1,389					8	289	n/a	59	1,795	3,666
31	63	82	158	244	350	771	611	939									1,183	2,036
32	43	73	52	80	204	444	739	1,199	96	179					n/a	90	1,134	2,065
33	116	163			59	117	124	195						69			299	543
34		-	51	74	105	236	60	94									217	404
35	119	168	55	77	89	158	192	303									455	706
36	61	98													n/a	55	61	154
37							69	122	33	57							102	180
38					71	124									n/a	20	71	144
39					62	127											62	127
40														47	n/a	4		51
41														45				45
42															n/a	13		13
43														41				41
45															n/a	3		3
56															n/a	54		54
58															n/a	4		4
Total	**11,382**	**36,707**	**4,951**	**10,632**	**22,179**	**63,760**	**70,392**	**176,243**	**3,017**	**15,616**	**708**	**1,521**	**426**	**18,002**	***n/a***	**8,275**	**113,055**	**330,756**

3.2 Lying Dead Wood Carbon Stocks

Total lying dead wood carbon stocks for each Public Land Survey System section (or portions thereof within the property) and the total project area in 2007 are shown in Table 10.

Total lying dead wood carbon stocks for each 2008 inventory stratum and the total project area are shown in Table 11.

Table 10. Estimates of lying dead wood on the Bascom Pacific Forest, by Public Land Survey System section and in total for 2007.

Location	Carbon Density (metric tons/acre)	Total Carbon (metric tons)
38N02E03	2.01	634.6
38N02E05	0.72	230.2
38N02E09	3.16	930.7
38N02E15	1.53	496.8
38N02E17	2.31	746.2
39N02E29	2.29	365.6
39N02E30	2.31	45.1
39N02E33	2.70	846.1
39N03E20	0.41	24.9
39N03E29	0.00	0.0
39N03E30	0.85	17.3
39N01W07	1.96	165.9
39N01W09	3.03	276.5
39N01W10	5.41	1,645.5
39N01W11	0.79	31.4
39N01W14	6.01	707.4
39N01W15	3.87	1,212.3
39N01W16	3.34	1,062.9
39N01W17	2.25	697.5
39N01W18	3.60	605.3
39N01W20	2.39	377.0
39N01W21	3.54	555.2
39N01W22	2.28	742.8
39N02W12	1.91	68.6
Average	**2.72**	**12,486**

Table 11. Estimates of lying dead wood on the Bascom Pacific Forest, by Public Land Survey System section and in total for 2008.

Stratum	Carbon Density (metric tons/acre)	Total Carbon (metric tons)
1	2.9	1,058
2	0.4	38
3	0.6	126
4	1.0	412
5	2.3	540
6	1.1	361
7	1.3	298
8	1.6	733
9	1.2	698
10	2.4	1,357
11	2.2	923
12	2.2	1,355
13	4.9	834
14	1.7	1,750
15	2.3	3,113
16	1.1	86
17	2.0	789
18	1.7	1,046
19	3.5	227
20	4.6	791
21	0.5	75
22	3.2	927
23	1.5	416
Average	**2.0**	**17,952**

3.3 Combined Pools

In order to determine the total carbon stocks for the project site all pools were combined. These pools include live trees (above- and below-ground), standing dead trees (above-ground only), and lying dead wood. Table 12 shows the carbon stocks for all pools in both 2006 and 2008.

Standard Error

The estimated mean carbon density for all carbon pools for the initial inventory at the project starting date in 2006 is 41.7 metric tons of carbon per acre. The standard error of the estimate of the mean at the 90% confidence level in 2006 is 1.23% (90% confidence interval: 41.2 – 42.2 metric tons per acre). The estimated mean carbon density for all carbon pools for the 2008 inventory is 47.2 metric tons of carbon per acre. The standard error of the estimate of the mean at the 90% confidence level in 2008 is 3.8% (90% confidence interval: 45.4 – 49.0 metric tons per acre).

Table 12. Total carbon stocks and carbon density within each pool and in total for the Bascom Pacific Forest.

	2006		2008	
Carbon Pool	Total Carbon (metric tons)	Carbon Density (metric tons/acre)	Total Carbon (metric tons)	Carbon Density (metric tons/acre)
Live Tree	368,544	40.1	402,457	44.3
Standing Dead Tree	3,142	0.3	8,275	0.9
Lying Dead Wood	12,486	1.4	17,952	2.0
Total	384,172	41.7	428,684	47.2

Although the standard error for the 2008 inventory is higher than for the 2006 inventory, we believe the 2008 inventory is a better inventory for several reasons. First, it is based on a single cruise design. Second, sampling for the 2008 inventory was conducted by a single crew. Third, it was conducted in a single year, at the end of the growing season. Each of these factors helps to increase the consistency of the data collection and the standards by which they were gathered, as well as the certainty about the inventory. Also, since the data that served as the basis for the 2006 inventory was gathered over several years prior to 2006, the inventory had to be grown and harvested through the CACTOS growth model. As a result, an additional layer of uncertainty is added to the 2006 inventory due to the uncertainty associated with the use of growth models since they are dependent on assumptions and parameters that do not perfectly reflect conditions on the ground, such as climatic variability and hydrologic conditions.

4.0 Planned Activities to Increase Carbon Stores

4.1 Modeling Baseline and Project Activities

In order to demonstrate that planned activities produce carbon stocks that are additional to the baseline case, changes to current carbon stocks are projected into the future under both the baseline activity scenario and the project activity scenario. These projections are generated with a growth and yield model that is capable of estimating future stand conditions, using current inventory data and specific management activities as input. As per the Forest Protocols, both scenarios are modeled 100 years into the future from the project starting date.

Baseline projections are determined by modeling changes to current carbon stocks under a management regime that approximates a harvest that maximizes the present net value of the timber resource while abiding to all applicable rules and laws. These baseline projections are compared to simulated carbon stock projections resulting from a myriad of possible management strategies that have the potential of developing relative carbon dioxide reductions. The management activities chosen for the Bascom Pacific Forest are based on terms within the Bascom Pacific Conservation Easement. The difference between the baseline scenario for the Bascom Pacific Forest and the project activity scenario represents the potential emissions reductions that could be achieved by the project.

Efforts were taken to establish baseline and project activity management scenarios that would generate conservative estimates of emissions reductions. In other words, the intent was to err on the side of generating fewer emissions reductions. This meant that when discretion was allowed in order to meet the general goals and objectives of modeling management that could occur under the baseline scenario, choices were generally made that would produce an estimate of baseline stocks that was more rather than less. Conversely, within the framework of the general management goals and objectives established for the project activity scenario, modeling was performed in a manner that would produce an estimate of project activity stocks that was less rather than more. Thus, with both scenarios being modeled conservatively within their overarching management goals and objectives, the difference between the two, and hence the reportable emissions reductions, was minimized.

4.2 Overview of Growth and Yield Modeling

Growth and yield modeling is based on 'growing' and 'harvesting' inventory data associated with the forest. The organization of inventory data usually includes a 'tree list' that represents the forest conditions within a forest stand, which is usually managed in a relational database and can be linked to a spatial database in a geographical information system. This section will discuss details of inventory growth and yield modeling. For the Bascom Pacific Project, growth and yield modeling was conducted using CACTOS, a growth model that has been approved by the Reserve for use in this region. Early growth in plantations was modeled using CONIFERS, a young stand simulator (Ritchie, 2008; http://www.fs.fed.us/psw/programs/ecology_of_western_forests/projects/conifers/). A tree list is assigned to each stand based on the stratified sampling process. The tree lists are 'grown' and 'harvested' based on their silviculture assignments within CACTOS. Modeling results are output on a 5-year basis, with a total modeling period of 100 years as required by the Forest Project Protocols.

4.3 Methodologies and Assumptions used to Model the Bascom Pacific Baseline Activity Scenario

As stated in the Background section, the baseline approach for a forest management project pursuant to version 2.1 of the Forest Protocols is a performance standard approach, reflecting the silvicultural practices required by Option C in sections 913.11, 933.11 and 953.11 of article 3 of the California Forest Practice Rules (14 CCR). The effects of watercourse rules and endangered species laws were also considered in the baseline analysis. Scenario Goal

The baseline activity scenario strived to maximize the net present value of the forest with only legal constraints to harvesting considered.

4.3.1 General Description

The upslope stands (stands outside of watercourse buffers and not part of designated sensitive habitat areas) on the project area sum to approximately 8,250 acres, or 92% of the project area. Watercourse protection areas include approximately 500 acres (a conservative estimate based on GIS-derived stream segment lengths and the maximum buffer widths specified in 14 CCR), or 5% of the project area, and designated sensitive habitat areas include approximately 280 acres, or 3% of the project area. After the area was researched for the presence of Northern Spotted Owls, it was determined that none are present on the property. Therefore no special mitigation is required.

4.3.2 Upslope Stands

The harvesting assumptions incorporated an even-aged harvesting regime on all upslope stands based on 60-year clearcut rotations. This rotation period is based on the regeneration length specified by Option (C) of 14 CCR for evenaged management on Site Class III lands. Option (C) also generally limits the size of clearcuts to 20 acres (allowing for up to 40 acres under certain conditions) and prohibits the clearcutting of adjacent stands. This adjacency rule was managed in the modeling process by partitioning the forest into 4 units of similar acreage, each representing a 5-year harvesting plan. Therefore, all stands that were stocked with trees 60 years or older were to be 'harvested' in the baseline model over a 20-year period. Stands were prioritized for harvesting based on their level of stocking – older and better stocked stands were harvested earlier than younger and less stocked stands.

Regeneration in clearcut stands was accomplished by assuming that 300 trees were planted on a per acre basis, where 200 trees were ponderosa pine and another 100 trees were Douglas-fir. An assumed 8% brush cover was also included in the post-harvest stand to mimic real life competitive conditions affecting growth among the seedlings following harvest.

Stands that were modeled with clearcut management were followed up with commercial thinning 45 years later. The thinning strategy removed 30% of the basal area from the stand by harvesting from among the smallest 30% of the diameter classes in the stands. These stands were clearcut a second time 15 years later, 60 years following the initial clearcut harvesting.

Table 13 below displays the acreage harvested under each treatment type in each five-year period for the baseline activity scenario.

4.3.3 Watercourse Stands

Watercourse stands will be harvested in the baseline scenario using single tree selection silviculture methods. The harvest will be limited in each stand to 35% of the standing volume every 10 years. This method approximates the selective harvesting permitted within stream zones while allowing a gradual increase in stand density over time. It is the intent of this harvesting approach to increase the inventory volume over time in this area.

4.3.4 Sensitive Stands

The sensitive stands were not considered for harvest in the baseline activity scenario.

4.4 Methodologies and Assumptions used to Model the Bascom Pacific Project Activity Scenario

As discussed previously in the *Section 1.2 Climate Action Reserve Forest Protocol and Its Key Principles*, a forest management project must demonstrate that it is additional by showing that the planned project activities exceed the applicable mandatory forest management laws used to characterize the project baseline.

The Bascom Pacific Conservation Easement specifies the allowable silviculture activities that can occur. The easement allows for uneven age harvest, as well as variable retention harvest with a maximum opening size of 10 acres. Harvest is limited to 80% of net timber growth per decade until an average conifer board foot stocking level of 25 thousand board feet per acre has been achieved. Harvest of up to 100% of growth can occur at that time.

4.4.1 Scenario Goal

The project activity scenario implemented the goals within the conservation easement.

4.4.2 General Description

The project scenario did not specify different management activities between the upslope stands and the watercourse buffers since only one silviculture activity was applied to all forested stands. The sensitive stands that comprise approximately 3% of the project area were not considered for harvest. Approximately 160 acres of brush-covered stands were present in the upslope areas. As with the baseline activity scenario, since no Northern Spotted Owls are present on the property, no special mitigation was required.

4.4.3 Upslope Stands and Watercourse Stands

These stands were managed with single tree selection. Harvests in these stands occurred every 10 years, which was intended to allow for revegetation of disturbed soils, establishment of regeneration trees, and sufficient volume growth to make the next harvest entry economically feasible. 80% of the growth in these stands was harvested at each entry. If the average conifer stocking level across the property reached 25 thousand board feet, harvest of up to 100% of the growth was allowed at that time.

Table 13 below displays the acreage harvested under each treatment type in each five-year period for the project activity scenario.

4.4.4 Brush-covered Stands

These stands were immediately managed to reduce brush competition to 8% cover on the landscape. Trees were then 'planted' to 200 trees per acre of ponderosa pine and 100 trees per acre of Douglas-fir. These stands were grown for 45 years at which point selection harvests occurred on a 10-year frequency.

Table 13. Acreage harvested under each treatment type by period for both the baseline activity and project activity scenarios.

	Harvest Acreage			
	Baseline Scenario		Project Scenario	
Period Beginning	*Clear-Cut*	*Thinning*	*Clear-Cut*	*Thinning*
2006	1,980	470	146	3,599
2011	1,984			4,638
2016	1,949	470		3,580
2021	1,914			4,638
2026		470		3,580
2031				4,638
2036		513		3,634
2041				4,638
2046	42	624		3,788
2051	93	2,194		4,747
2056		2,454		4,085
2061	193	1,949		4,753
2066	2,222	2,384		4,085
2071	1,984			4,760
2076	1,949	470		4,085
2081	1,914			4,760
2086		470		4,085
2091		42		4,768
2096		563		4,090
2101				4,768

4.5 Methodologies and Assumptions used to Model Wood Products

Carbon stored in wood products is an optional reporting pool under version 2.1 of the Forest Protocols. In recognition of the fact that some amount of live tree carbon continues to be stored in wood products after timber harvest and manufacturing, contributions and changes to carbon stores in wood products were calculated based on projected harvests in both the baseline activity and project activity modeling scenarios.

The authors note that accounting of the long-term stores in harvested wood products net of primary and secondary greenhouse effects (e.g., logging and manufacturing associated losses, fuels combustion from same and transportation, etc.) is difficult if not impossible to ascertain with accuracy at the level of an individual project absent more comprehensive accounting for the forest sector overall and the flow of wood within the forest sector and across to other sectors.

At the project level, unlike on-site forest carbon stocks and flux, post-harvest wood products carbon flows out of the project owner's control; end uses and losses vary widely along the chain of custody; and the ultimate destiny of the harvested wood products carbon is not amenable to independent verification. The best available data on which to base these necessarily general calculations has relatively high uncertainty (Skog communication to the Reserve's Work Group 2009). Nonetheless, this is what has been used to create the wood products in use and in landfills tables utilized in the Department of Energy's 1605(b) program and, by derivation, to underpin the Forest Protocols. The challenge is how to begin to conservatively quantify and account for harvested wood products carbon at the project level given the above constraints. Since the amount of harvested wood products produced under the baseline scenario is generally higher over the course of the project lifetime, a conservative accounting would err on the side of reporting more wood products carbon than less. Thus the baseline stocks would increase relative to the project activity stocks.

Ultimately this accounting challenge needs to be resolved through a comprehensive system that allows forest owners to account for logs delivered to mills net of harvest and transportation based emissions. Losses and continued stores associated with primary and secondary processing, transportation, construction, biomass energy, other uses, landfills, recycling, etc., would be accounted for in their respective sectors. Such an integrated approach to forest accounting would provide the basis for crediting the use of wood over more carbon intensive fuels and building materials in their respective sectors.

In the case of the subject Bascom Pacific project modeling exercise, as with other modeling results, projected harvest volumes are output on a 5-year basis. Since the methodology outlined in the Forest Protocols for calculating changes to the wood products pool incorporates annual decay rates, projected harvest volumes were annualized, with the assumption that the volume of timber harvested during each year within a given 5-year modeling period remained constant. For example, if 5,000 thousand board feet (MBF) were projected to be harvested during a given 5-year model output period, it was assumed that 1,000 MBF was harvested in each of the years during that period.

Annual harvested timber volumes were separated by species and species specific conversion factors were applied to convert from board foot volumes into wood weight and, subsequently, into carbon weight. These carbon weights were then totaled to determine the total weight of carbon harvested for transfer to the wood products pool. But not all wood harvested and delivered to a mill actually makes it into wood products due to inefficiencies in the process to convert a whole log into a finished wood product. As per the Forest Protocols, an efficiency factor of 60 percent is applied to the harvested carbon weight. Thus, 40 percent of the carbon weight is deducted and is considered to be immediately decayed and emitted back to the atmosphere.

The remaining carbon weight is allocated into different wood product classes in order to apply decay rates specific to each product class throughout the project lifetime. Thus, in any given year, the carbon weight harvested and processed into a specific wood product class in a given year is added to the running total weight for that wood products class. Of the wood that actually makes it into finished wood products for this project, it was assumed that 47.5 percent of harvested wood was processed into lumber that was incorporated into single-family homes (post-1980) and into multifamily houses, each a separate wood product class. The remaining 5 percent of harvested wood was assumed to be processed into lumber used for residential maintenance and repair. The allocation of harvested timber into various product classes was determined through discussions with local foresters knowledgeable of the wood products processed by the mills that have received logs from the project site during recent harvests. It was assumed that such mills would continue operation throughout the project lifetime, that they would continue processing the same wood product classes, and that the proportional distribution of logs received by them into the various wood product classes would remain the same.

For each year of the project, the total carbon weight for each wood products class is determined by adding the carbon weight of the wood products processed in the current year to the carbon weight of the wood products in the same class remaining from the previous year. A product class-specific decay rate is then applied to this total carbon weight to determine the amount of carbon that remains sequestered in wood products for the current year. Annual wood products carbon is determined by summing the remaining carbon weights from each individual wood product class. Furthermore, the remaining carbon weights from each individual wood product class are carried forward to calculate the total carbon in each class the following year. Decay rates are provided in the Forest Protocols and are based on the work of Row & Phelps (1996) and Skog & Nicholson (2000), which identify the half-life of carbon by wood product class. The half-life of the wood products classes applicable to this project are as follows: single-family homes (post-1980) = 100 years, multifamily houses = 70 years, and residential maintenance and repair = 30 years. As provided in the Forest Protocols, the general formula used to calculate annual wood products carbon for a given wood product class is as follows:

$$WP = (X + Y) + [(X + Y) * \ln(0.5) / Z]$$

Where:

X = weight of carbon (metric tons) harvested and transferred to the wood product class during the current year

Y = weight of carbon (metric tons) remaining from the previous year

Z = the half life, in years, of the wood product class

This calculation is performed annually for each wood product class based on the projected timber harvest volumes in a given year for each scenario. These results for individual wood product classes are summed to determine the total amount of carbon in wood products each year. In effect, the amount of wood products carbon calculated in a given year (WP_x) becomes the value for Y used to calculate the amount of carbon in the wood products pool the following year (WP_{x+1}).

5.0 Results of Modeling Activities

5.1 On-Site Carbon Pools Modeling Results

Tables 14 and 15 show the results of the modeled projections for the baseline activity scenario and the project activity scenario, respectively. Results in these tables and in the initial comments here indicate on-site carbon pools only. The wood products pool results are indicated in a separate sub-section later.

The baseline scenario carbon stocks follow a pattern typical of evenage-managed forests, whereby timber stocks are rapidly depleted and then regrown at a slower pace over a longer period of time. In this case, a specific rotation length was specified, producing an evident cyclical pattern over 60 years (Figure 6) in which the first 20 years are marked by successive clearcut treatments, followed by a 40-year growth period before the first stands that were harvested may be clearcut again. During the 40 years of growth, commercial thinning entries occur, as specified in the baseline activity scenario description above. Although such treatments cause small reductions in carbon stocks, they serve to stimulate more rapid growth in the residual stand, and thus more rapid carbon sequestration. Clearcutting is projected to reduce carbon stocks on the Bascom Pacific Forest from 384,172 metric tons (41.7 tons/acre) at project initiation in 2006 to 97,783 metric tons (10.6 tons/acre) in 2026. At the start of the second clearcutting cycle in 2066, carbon stocks would reach 507,954 metric tons (55.2 tons/acre) before being reduced to 134,728 metric tons (14.6 tons/acre) in 2086. At the end of the 100-year modeling period, the site would have 307,096 metric tons of carbon (33.4 tons/acre). The total volume harvested under the baseline scenario is projected to be approximately 448,000 thousand board feet.

Under the project activity scenario, the overall carbon stocks on the site are projected to gradually increase over time (Figure 6). This is due to the easement restriction that specifies that, until the average stocking for the site reaches 25 thousand board feet per acre, only 80% of growth may be harvested. Since the stocking on the site is not projected to achieve this threshold during the 100-year modeling period, harvest levels are kept at an average of about 77% of growth. Carbon stocks on the project site are projected to increase from 384,172 metric tons (41.7 tons/acre) in 2006 to 603,458 metric tons (65.6 tons/acre) in 2106. Total harvest volume during the modeling period is projected to be about 418,000 thousand board feet, or approximately 93% of the volume harvested under the baseline scenario.

Emissions reductions that would be expected to be generated by the Bascom Pacific Forest Project are determined by comparing the projected carbon stocks under the project activity scenario over time to those projected under the baseline activity scenario over time. According to the Forest Protocols, subtracting the baseline activity carbon stocks from the project activity carbon stocks in a given year determines the “project carbon” for that year. Project carbon may also be considered the cumulative carbon (or carbon dioxide) reductions generated by a project at that given point in time. As such, a positive project carbon value indicates that more carbon dioxide has been removed from the atmosphere under the project activity scenario than would have been removed under the baseline activity scenario. However, in order to determine annual emissions reductions, the Protocols stipulate that project carbon from the previous year be subtracted from the project carbon from the current year. Thus, a positive difference indicates a reduction in carbon stocks or carbon dioxide emissions from one year to the next, whereas a negative difference indicates an increase is carbon stocks or carbon dioxide emissions.

Figure 6 and Table 16 provide a comparison of the projected baseline activity and project activity carbon stocks throughout the 100-year modeling period, as well as cumulative carbon dioxide reductions and periodic carbon dioxide reductions. In this case, periodic emissions reductions are reported rather than annual emissions reductions since modeling was performed on a 5-year basis. The cumulative CO_2 reductions achieved at the end of the 100-year modeling period are 1,086,466 metric tons (118.1 tons/acre). However, the maximum cumulative carbon dioxide reductions achieved during the project lifetime, 1,632,062 metric tons of CO_2 (177.4 tons/acre), would be achieved in 2086 at the end of the second clearcut cycle. The minimum cumulative carbon dioxide reductions during the modeling period, 161,659 metric tons of CO_2 (17.6 tons/acre), would occur immediately prior to the start of the second clearcut cycle in 2066, coinciding with the peak carbon stocks achieved by the baseline scenario. The maximum periodic carbon dioxide reductions would occur in 2021, resulting in 428,611 metric tons of additional CO_2 (46.6 tons/acre) sequestered since 2016. On the other hand, the greatest periodic carbon dioxide emissions (i.e. minimum reductions) relative to the baseline would occur when 227,274 metric tons of CO_2 (24.7 tons/acre) would be emitted between 2061 and 2066.

5.2 Wood Products Modeling Results

The incorporation of the wood products pool accounting into the modeling results increases the projected carbon stocks under both the baseline activity and project activity scenarios. Yet the impact on the carbon stocks in each scenario varies due to differences in the amount of timber harvested during the project lifetime. Since the total carbon stocks in each scenario are affected differently, the resulting emissions reductions are also affected, especially in comparison to when the wood products pool is not included in project accounting.

Over the life of the project, 447,877 MBF are harvested under the baseline activity scenario, whereas 417,563 MBF are harvested under the project activity scenario (Tables 14 and 15). The amount of timber harvested in any given period of time varies considerably under the baseline activity scenario, with significant pulses during the periods in which clearcutting occurs, more modest harvest volumes when intermediate thinning takes place, and no volume harvested in some periods as standing timber volume is allowed to accumulate on clearcut sites. Although the baseline activity scenario exhibits an average harvest rate of about 4,475 MBF per year, as much as 7,413 MBF per year are harvested per year during the initial clearcut phase and up to 14,820 MBF per year in the second clearcut phase, but only between about 1,000 and 3,000 MBF per year during intermediate thinnings and 0 MBF during fallow years. The wood products carbon pool reflects these changes by accumulating rapidly during clearcutting phases, and more slowly during intermediate thinning phases (Figure 7). But during the periods in which no harvesting occurs, decay of existing wood products leads to a slight decrease in the overall stocks in this pool. At the end of the project lifetime, the baseline activity scenario has a total of 88,775 metric tons of carbon in the wood products pool.

Table 14. Projections of inventory volumes, harvest volumes and carbon stocks under the Baseline Activity Scenario.

Year	Acres Harvested	Total Net Board Foot Volume (MBF)	Total Net Conifer Board Foot Volume (MBF)	Net Conifer Board Foot Growth Per Year (MBF/yr)	Annual Net Conifer Board Feet Harvested (MBF/yr)	Annual Net Conifer Volume Harvested as % of Total Net Conifer Volume	Carbon Above-ground (mt)	Carbon Below-ground (mt)	Lying Dead Wood (LDW) Carbon (mt)	Total Onsite Carbon (Above, Below & LDW) (mt)	Total Onsite Carbon Density (mt/acre)	Harvested Wood Products Carbon (mt)	Total Carbon, (Onsite & Harvested Wood Products) (mt)	Total Carbon Density (Onsite & Harvested Wood Products) (mt/acre)
2006	2,450	91,906	90,382	4,044	5,255	5.81%	296,058	75,629	12,486	384,172	41.7	0	384,172	41.7
2011	1,984	85,845	84,326	2,878	5,740	6.81%	268,126	69,288	12,486	349,899	38.0	7,601	357,500	38.9
2016	2,419	71,453	70,015	2,234	7,413	10.59%	213,124	56,566	12,486	282,176	30.7	15,563	297,739	32.4
2021	1,914	45,411	44,118	645	6,036	13.68%	135,075	37,806	12,486	185,367	20.1	25,593	210,959	22.9
2026	470	17,597	17,164	1,742	726	4.23%	65,385	19,913	12,486	97,784	10.6	33,187	130,970	14.2
2031	-	22,771	22,241	1,711	-	0.00%	89,664	26,322	12,486	128,471	14.0	32,768	161,239	17.5
2036	513	31,423	30,794	3,642	1,091	3.54%	121,007	34,304	12,486	167,797	18.2	31,325	199,122	21.6
2041	-	44,274	43,552	3,784	-	0.00%	161,707	44,321	12,486	218,514	23.7	31,531	250,045	27.2
2046	708	63,295	62,474	6,379	1,476	2.36%	201,980	53,945	12,486	268,411	29.2	30,157	298,567	32.4
2051	2,315	87,898	86,988	7,086	2,318	2.66%	248,892	64,877	12,486	326,254	35.5	30,983	357,238	38.8
2056	2,454	111,468	110,830	9,401	2,933	2.65%	288,957	74,024	12,486	375,466	40.8	32,995	408,461	44.4
2061	2,145	143,869	143,168	10,071	1,842	1.29%	339,825	85,427	12,486	437,738	47.6	35,812	473,550	51.5
2066	4,606	185,078	184,317	10,133	14,820	8.04%	397,377	98,092	12,486	507,954	55.2	36,929	544,883	59.2
2071	1,984	161,369	160,882	5,413	11,064	6.88%	329,940	83,228	12,486	425,653	46.3	56,771	482,425	52.4
2076	2,419	133,145	132,629	5,271	12,858	9.69%	260,650	67,578	12,486	340,713	37.0	70,301	411,014	44.7
2081	1,914	95,239	94,692	922	10,673	11.27%	178,508	48,366	12,486	239,360	26.0	85,831	325,190	35.3
2086	470	46,518	45,940	3,735	2,404	5.23%	94,635	27,607	12,486	134,728	14.6	97,519	232,247	25.2
2091	42	53,200	52,595	2,049	28	0.05%	119,096	33,825	12,486	165,407	18.0	96,741	262,148	28.5
2096	563	63,330	62,702	5,837	2,900	4.63%	150,833	41,677	12,486	204,995	22.3	92,579	297,574	32.3
2101	-	78,037	77,385	4,186	-	0.00%	192,136	51,615	12,486	256,236	27.8	92,772	349,008	37.9
2106		98,991	98,316				233,330	61,280	12,486	307,096	33.4	88,775	395,871	43.0

Table 15. Projections of inventory volumes, harvest volumes and carbon stocks under the Project Activity Scenario.

Year	Acres Harvested	Total Net Board Foot Volume (MBF)	Total Net Conifer Board Foot Volume (MBF)	Net Conifer Board Foot Growth Per Year (MBF/yr)	Annual Net Conifer Board Feet Harvested (MBF)	Annual Net Conifer Volume Harvested as % of Total Net Conifer Volume	Carbon Above-ground (mt)	Carbon Below-ground (mt)	Lying Dead Wood (LDW) Carbon (mt)	Total Onsite Carbon (Above, Below & LDW) (mt)	Total Onsite Carbon Density (mt/acre)	Harvested Wood Products Carbon (mt)	Total Carbon, (Onsite & Harvested Wood Products) (mt)	Total Carbon Density (Onsite & Harvested Wood Products) (mt/acre)
2006	3,834	91,906	90,382	4,349	2,944	3.26%	296,058	75,629	12,486	384,172	41.7	0	384,172	41.7
2011	4,641	99,392	97,406	4,435	3,471	3.56%	320,776	81,182	12,486	414,443	45.0	4,258	418,701	45.5
2016	3,605	104,416	102,224	4,557	3,098	3.03%	330,570	83,368	12,486	426,424	46.3	9,089	435,512	47.3
2021	4,641	112,552	109,518	4,490	4,200	3.83%	347,020	87,023	12,486	446,529	48.5	13,165	459,695	50.0
2026	3,605	114,808	110,969	4,629	3,189	2.87%	351,374	87,987	12,486	451,846	49.1	18,655	470,502	51.1
2031	4,641	123,117	118,168	4,598	4,214	3.57%	369,618	92,012	12,486	474,116	51.5	22,441	496,557	54.0
2036	3,605	125,391	120,086	4,849	3,266	2.72%	372,516	92,649	12,486	477,651	51.9	27,546	505,197	54.9
2041	4,641	134,515	128,003	4,875	4,161	3.25%	391,969	96,911	12,486	501,366	54.5	31,056	532,422	57.9
2046	3,648	137,582	131,571	5,122	3,591	2.73%	392,433	97,013	12,486	501,932	54.5	35,710	537,642	58.4
2051	4,641	146,426	139,229	5,134	4,232	3.04%	409,827	100,802	12,486	523,115	56.8	39,337	562,452	61.1
2056	4,106	150,138	143,740	5,438	3,897	2.71%	411,321	101,127	12,486	524,934	57.0	43,737	568,671	61.8
2061	4,783	158,944	151,444	5,681	4,361	2.88%	426,851	104,494	12,486	543,830	59.1	47,464	591,294	64.3
2066	4,106	165,359	158,044	5,869	4,457	2.82%	433,611	105,954	12,486	552,051	60.0	51,703	603,755	65.6
2071	4,783	173,450	165,102	6,031	4,527	2.74%	442,425	107,855	12,486	562,765	61.2	55,901	618,666	67.2
2076	4,106	180,590	172,619	6,117	4,974	2.88%	448,311	109,122	12,486	569,919	61.9	60,020	629,940	68.5
2081	4,783	187,333	178,337	6,351	4,575	2.57%	450,844	109,667	12,486	572,997	62.3	64,610	637,607	69.3
2086	4,106	195,697	187,218	6,282	5,345	2.86%	456,541	110,890	12,486	579,917	63.0	68,428	648,344	70.5
2091	4,783	201,309	191,899	6,515	4,757	2.48%	456,000	110,774	12,486	579,259	62.9	73,199	652,458	70.9
2096	4,106	210,251	200,690	6,481	5,536	2.76%	465,841	112,884	12,486	591,211	64.2	76,915	668,125	72.6
2101	4,783	215,902	205,417	6,665	4,718	2.30%	465,974	112,912	12,486	591,372	64.3	81,602	672,974	73.1
2106		225,459	215,151				475,931	115,042	12,486	603,459	65.6	84,908	688,367	74.8

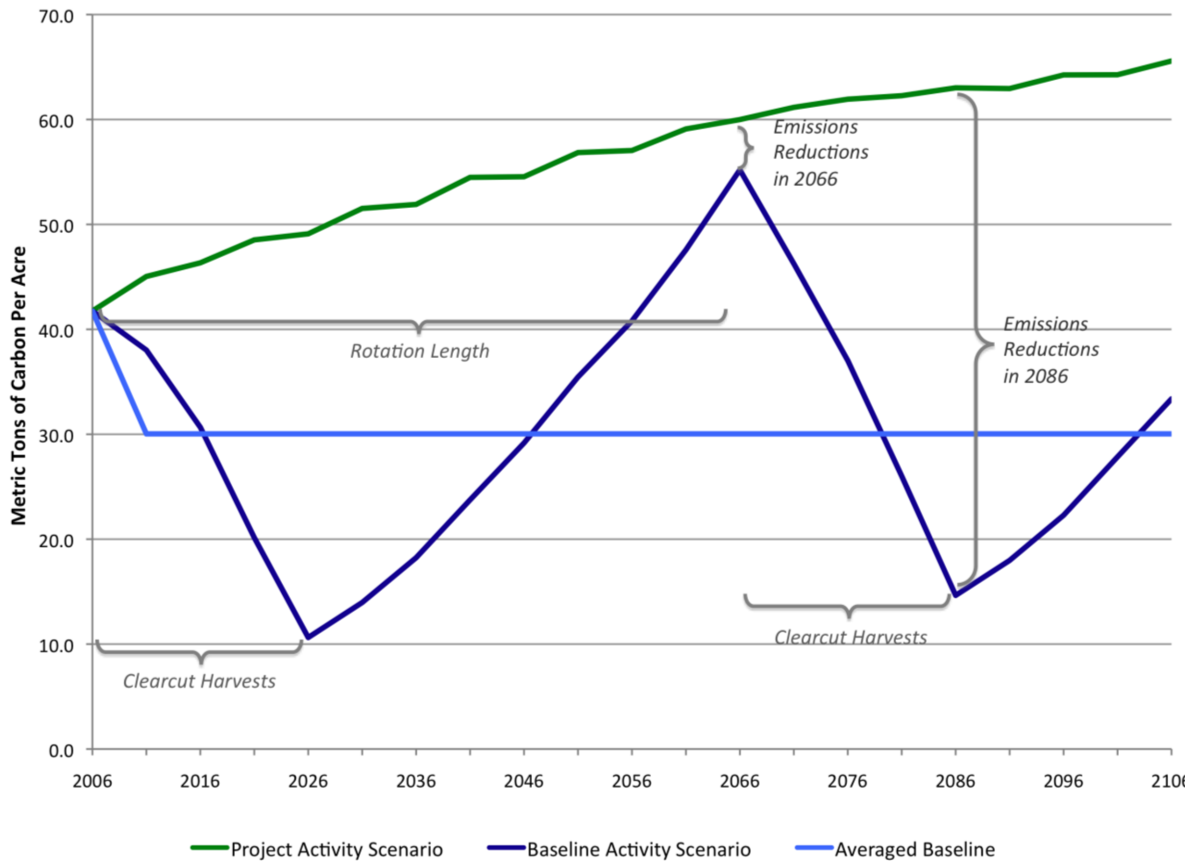

Figure 6. Comparison of projected baseline activity scenario and project activity scenario carbon stocks on a per acre basis over the 100-year project lifetime. The averaged baseline activity value is also shown. All scenarios have the same initial carbon stocks at the project start date in 2006. The averaged baseline curve begins at this same starting value, but achieves the average value by the end of the first 5-year reporting period by being reduced annually in equal increments.

Table 16. Comparison of carbon dioxide stocks produced by the Baseline Activity Scenario and the Project Activity Scenario, and summary of emissions reductions achieved by the Bascom Pacific Project. The table includes emissions reductions calculations based on a comparison between the Project Activity Scenario and the average carbon stocks determined for the Baseline Activity Scenario. Shaded columns indicate the inclusion of the wood products in calculated carbon dioxide totals.

	Baseline Activity Scenario		Project Activity Scenario		Forest Project Protocol CO_2 Reductions Calculations				CO_2 Reductions Calculations Based On Averaged Baseline					
							Including Wood Products					Including Wood Products		
Year	Baseline Metric CO_2 Tons	Baseline Metric CO_2 Tons w/ Wood Products	Project Activity Metric CO_2 Tons	Project Activity Metric CO_2 Tons w/ Wood Products	Cumulative CO_2 Reductions	Periodic CO_2 Reductions	Cumulative CO_2 Reductions	Periodic CO_2 Reductions	Averaged Baseline CO_2 Metric Tons	Cumulative CO_2 Reductions	Periodic CO_2 Reductions	Averaged Baseline CO_2 Metric Tons	Cumulative CO_2 Reductions	Periodic CO_2 Reductions
2006	0	1,408,375	0	1,408,375	0		0		-	0		-	0	
2011	7,601	1,310,594	4,258	1,534,958	-3,342	(3,342)	224,364	224,364	48,844	(44,586)	(44,586)	1,192,310	342,648	342,648
2016	15,563	1,091,513	9,089	1,596,588	-6,475	(3,132)	505,076	280,711	48,844	(39,756)	4,830	1,192,310	404,279	61,630
2021	25,593	773,377	13,165	1,685,241	-12,427	(5,953)	911,864	406,788	48,844	(35,679)	4,077	1,192,310	492,931	88,653
2026	33,187	480,137	18,655	1,724,859	-14,531	(2,104)	1,244,722	332,858	48,844	(30,189)	5,490	1,192,310	532,549	39,618
2031	32,768	591,102	22,441	1,820,379	-10,327	4,205	1,229,276	(15,446)	48,844	(26,403)	3,786	1,192,310	628,069	95,520
2036	31,325	729,982	27,546	1,852,053	-3,779	6,548	1,122,071	(107,205)	48,844	(21,298)	5,105	1,192,310	659,743	31,674
2041	31,531	916,667	31,056	1,951,860	-475	3,304	1,035,193	(86,878)	48,844	(17,789)	3,510	1,192,310	759,550	99,807
2046	30,157	1,094,548	35,710	1,970,995	5,554	6,029	876,447	(158,746)	48,844	(13,134)	4,654	1,192,310	778,685	19,135
2051	30,983	1,309,634	39,337	2,061,950	8,354	2,801	752,316	(124,131)	48,844	(9,507)	3,627	1,192,310	869,640	90,955
2056	32,995	1,497,420	43,737	2,084,749	10,742	2,388	587,329	(164,987)	48,844	(5,107)	4,400	1,192,310	892,439	22,799
2061	35,812	1,736,034	47,464	2,167,683	11,652	910	431,649	(155,680)	48,844	(1,380)	3,727	1,192,310	975,373	82,934
2066	36,929	1,997,540	51,703	2,213,364	14,775	3,123	215,824	(215,826)	48,844	2,859	4,240	1,192,310	1,021,054	45,681
2071	56,771	1,768,569	55,901	2,268,030	-871	(15,646)	499,461	283,637	48,844	7,056	4,197	1,192,310	1,075,720	54,666
2076	70,301	1,506,777	60,020	2,309,359	-10,280	(9,410)	802,582	303,121	48,844	11,176	4,120	1,192,310	1,117,049	41,329
2081	85,831	1,192,148	64,610	2,337,468	-21,220	(10,940)	1,145,320	342,739	48,844	15,766	4,590	1,192,310	1,145,158	28,109
2086	97,519	851,418	68,428	2,376,831	-29,091	(7,871)	1,525,413	380,092	48,844	19,583	3,817	1,192,310	1,184,521	39,363
2091	96,741	961,036	73,199	2,391,912	-23,543	5,549	1,430,876	(94,537)	48,844	24,354	4,771	1,192,310	1,199,602	15,081
2096	92,579	1,090,907	76,915	2,449,348	-15,664	7,879	1,358,441	(72,435)	48,844	28,070	3,716	1,192,310	1,257,038	57,436
2101	92,772	1,279,464	81,602	2,467,123	-11,170	4,494	1,187,660	(170,781)	48,844	32,758	4,687	1,192,310	1,274,814	17,776
2106	88,775	1,451,262	84,908	2,523,552	-3,867	7,303	1,072,290	(115,370)	48,844	36,063	3,306	1,192,310	1,331,242	56,429

The project activity scenario exhibits more consistent harvest rates over time, with harvests occurring every year during the project lifetime and ranging from about 3,000 MBF per year to 5,500 MBF per year, with an average of about 4,175 MBF per year over the project lifetime. The wood products carbon pool reflects this consistent rate of harvest by increasing consistently throughout the project lifetime (Figure 7). At the end of the project lifetime, the project activity scenario has a total of 84,908 metric tons of carbon in the wood products pool.

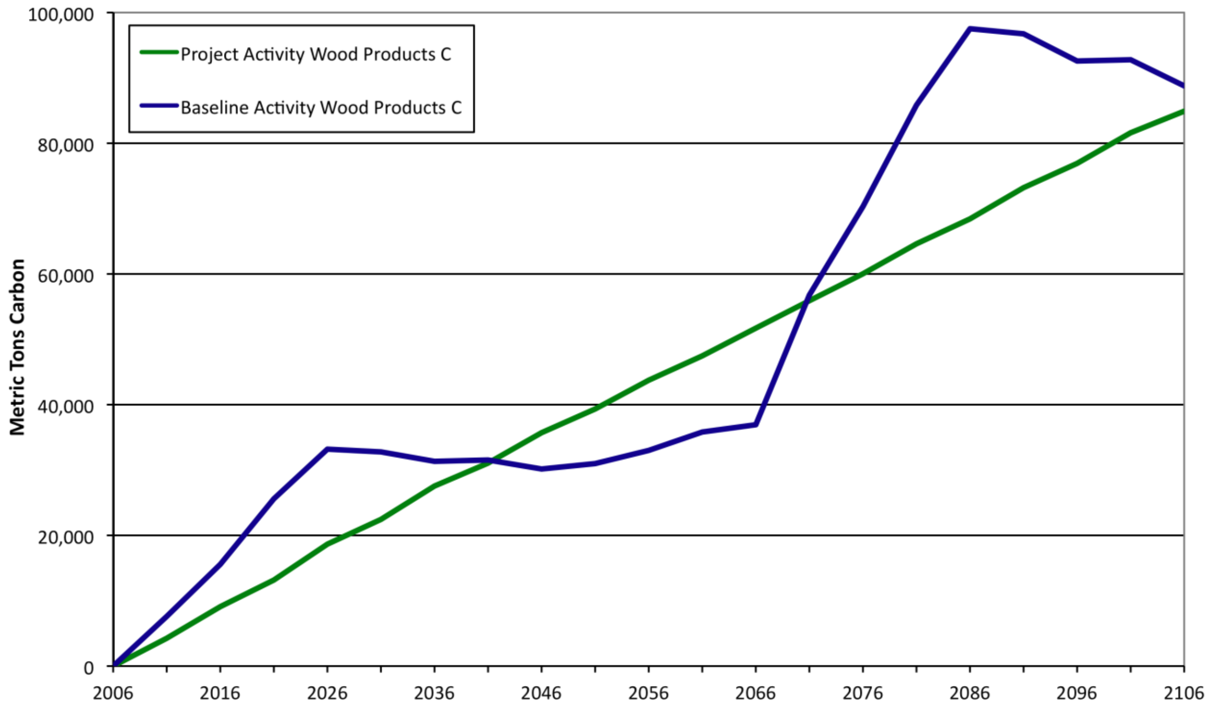

Figure 7. Baseline activity and project activity wood products pool stocks over the 100-year project lifetime.

Combining the wood products pool with the standing live tree, standing dead tree and lying dead wood pools increases the amount of carbon stored under both the baseline activity and project activity scenarios (Figure 8). Yet since each scenario differs in the amount of carbon transferred into the wood products pool both annually and throughout the project lifetime, the emissions reductions generated by the project are affected when the wood products pool is incorporated into the project accounting. Table 16 reveals that the emissions reductions under the standard calculations (project activity CO_2 – baseline activity CO_2) are generally lowered over the project lifetime compared to when wood products are not considered. At the end of the project lifetime, the cumulative emissions reductions are 14,176 tons of CO_2 less when wood products are considered than when they are not. However, from 2046 to 2066, emissions reductions for the project are actually higher when wood products are incorporated.

When the baseline values are averaged over the project lifetime, inclusion of wood products increases the baseline average by 179,064 tons of CO_2. Incorporating wood products also increases the cumulative emissions reductions at the end of the project lifetime by 132,208 tons of CO_2. However, cumulative emissions reductions including wood products remains lower than emissions reductions without wood products until 2066, at which point emissions reductions including wood products is greater through the remainder of the project lifetime.

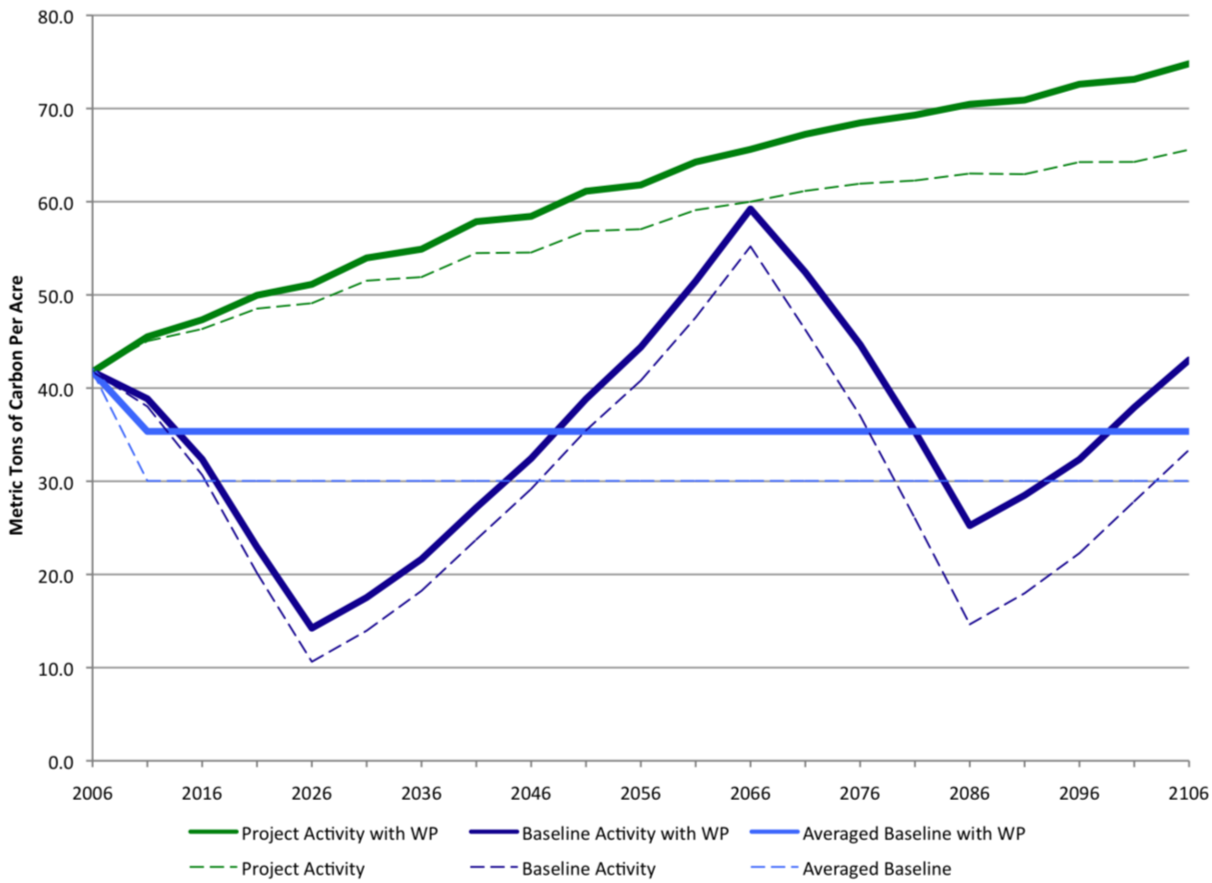

Figure 8. Baseline and project activity carbon stocks, both with and without wood products pool stocks, over the 100-year project lifetime on a per acre basis. The averaged baseline activity value is also shown. All scenarios have the same initial carbon stocks at the project start date in 2006. The averaged baseline curve begins at this same starting value, but achieves the average value by the end of the first 5-year reporting period by being reduced annually in equal increments.

5.3 2008 Project Stocks Monitoring

The 2008 carbon inventory update suggests that project stocks increased during the two-year time span since the project was initiated in 2006 (Table 17). Total carbon increased 44,512 metric tons between 2006 and 2008, from 384,172 metric tons to 428,684 metric tons. Of this increase, live tree carbon accounted for 33,912 metric tons, standing dead trees accounted for 5,133 metric tons, and lying dead wood accounted for 5,466 of the increase, though the increases in both dead pools may be due in part to changes made to the sampling methodologies used in 2008. Regardless, since the emissions reductions for a project are based on the difference between the project activity stocks and the baseline activity stocks, this increase in actual project stocks over the anticipated amount results in a corresponding increase in emissions reductions through the year 2008.

Table 17. Total carbon and carbon density in 2006 and 2008 for required reporting pools, and including the wood products pool.

Carbon Pool	Total C (mt)			C Density (mt/acre)			% Change from 2006 to 2008	
	2006	2008		2006	2008			
		Projected	*Actual*		*Projected*	*Actual*	*Projected*	*Actual*
Live Tree	368,544	380,653	402,457	40.1	41.4	44.3	3.3%	9.2%
Standing Dead Tree	3,142	3,142	8,275	0.3	0.3	0.9	0.0%	163.4%
Lying Dead Wood	12,486	12,486	17,952	1.4	1.4	2.0	0.0%	43.8%
Total	384,172	396,280	428,684	41.7	43.1	47.2	3.2%	11.6%
Wood Products	0	1,727	184	0.0	0.2	0.0	n/a	n/a
Total	384,172	398,007	428,868	41.7	43.3	47.2	3.6%	11.6%

Modeling of the baseline activity scenario projected a 2008 baseline stocking of 370,463 metric tons of carbon. Modeling of the project activity scenario predicted that stocks at the project site would increase to 396,280 metric tons. As such, the projected amount of emissions reductions for 2008 was 25,817 metric tons of carbon, or 94,647 tons of carbon dioxide. However, the inventory update in 2008 established project stocks of 428,684 metric tons, which result in actual emissions reductions equaling 58,221 metric tons of carbon, or 213,438 tons of CO_2.

Incorporating the wood products pool into the calculations for 2008 stocks impacts the resulting emissions reductions. Including wood products carbon in the baseline stocks for 2008 produces a baseline value of 373,545 metric tons of carbon, an increase of just over 3,000 metric tons. Adding wood products to the actual 2008 project stocks, based on the volume of timber harvested on the project site through the end of 2008, increases the actual project stocks to 428,868 metric tons of carbon, an increase of less than 200 metric tons. Since the baseline stocks are increased more than the project stocks with the addition of wood products carbon, the resulting emissions reductions are reduced to 55,323 metric tons of carbon, or 202,814 tons of CO_2.

6.0 Discussion of Modeling Results

6.1 On-Site Carbon Pools

Significant carbon dioxide emissions reductions would be expected to be achieved over a 100-year time period on the Bascom Pacific Forest given the assumptions and management scenarios used to model the baseline activity and project activity carbon stocks. Approximately 32.2 metric tons of additional C/acre, or 118.1 metric tons of CO_2/acre, would be stored on the site at the end of the project lifetime, equating to an annualized accrual rate of 0.32 metric tons of C/acre, or 1.18 metric tons of CO_2/acre, per year.

Yet the emissions reductions achieved from year to year fluctuate considerably throughout the modeling period, with significant reductions achieved during some periods and significant emissions produced during other periods. The results of these projections have significant implications for the annual carbon stocks reporting that would occur throughout the project lifetime, as required by the Forest Protocols. Based on the results here, the project developer would be able to report emissions reductions in years when the difference between the baseline activity and project activity stocks increases. But in years when the difference between the baseline activity and project activity stocks decreases, the project developer would be required to report an increase in emissions, also known as a reversal.

Given the relatively consistent increase in carbons stocks under the project activity scenario, these reversals in reductions trends are clearly caused by the baseline activity scenario (Figure 6). Periods during which clearcut harvests are occurring swiftly remove timber from the site, resulting in a rapid decline in baseline activity carbon stocks. Emissions reductions calculated during these periods increase at an even greater rate since the project activity carbon is increasing while the baseline activity carbon is decreasing.

This trend is reversed, though, once the clearcut harvest period ends in the baseline activity scenario and the forest remains relatively fallow while the stands are allowed to regenerate until the end of the 60-year rotation period. During these growth periods, the rate at which carbon stocks increase in the baseline scenario is significantly higher than the rate of increase exhibited by the project scenario. As a result, calculations of emissions reductions during these periods produce a negative value. In other words, the project activity is sequestering less carbon per year than the baseline activity. Thus, the project activity may be said to be producing CO_2 emissions relative to the baseline activity during such periods.

While the Protocol stipulates the 100 year "permanence period", this situation highlights the potential importance of the time scale used for the analysis. The time scale used for this analysis, as guided by the Forest Protocols, is 100 years. The net emissions reductions generated after 100 years in this instance (i.e. in 2106) are 1,086,466 metric tons of CO_2. However, if the analysis was to end just 20 years earlier in 2086, the net emissions reductions that could be said to have been generated are 1,632,062 metric tons of CO_2, or 545,596 metric tons more than after 100 years. Yet an analysis period ending only 20 years prior to that (i.e. 2066) would produce net emissions reductions of merely 161,659 metric tons of CO_2, or 924,807 metric tons less than after 100 years. Thus, the perceived overall benefits of the project vary considerably over time and may be dependent on the timeframe that is considered.

One could then take the point of view from this flux in emissions reductions that those to be considered additional (or permanent) under the current version of the Protocols should be limited to the minimum difference between the project activity and the baseline activity over the project lifetime. Determining the permanent emissions reductions based on this minimum value is a logical conclusion if one holds that any carbon emitted between the peaks in the baseline curve is irrelevant since it will be re-captured prior to the start of each clearcutting cycle. In the case presented here, the minimum difference is 161,659 metric tons of CO_2 over the 100-year modeling timeframe.

Yet, on the other hand, it is also reasonable to argue that the average value of the baseline curve throughout the 100-year modeling period should determine the emissions reductions for a project. This is because the long term net effect of the project relative to such a baseline is the removal of *X* tons of CO_2 from the atmosphere on average throughout time, with fluctuations of *Y* tons above or below *X* at any given point in time. The application of this concept to our results is shown in Figure 1 and Table 16. The average baseline CO_2 stocks for the 100-year modeling period are 1,013,246 metric tons, or 110.1 tons per acre. Throughout the project lifetime, periodic emissions reductions would simply mirror the changes in the project activity stocks, increasing when they increase and decreasing when they decrease.

During the modeling period in this study, the project activity steadily increases from 153.1 tons of CO_2 per acre to 240.4 tons per acre. If an average baseline approach is taken, when looking at periodic reporting, the first reporting period would see an initial pulse of an unusually high amount of emissions reductions projected due largely to the baseline stocks decreasing rapidly from the initial starting stocks, which are the same as the project activity starting stocks. In this case, the projected emissions reductions based on an averaged baseline in the first reporting period would be 506,101 metric tons of CO_2, or 55.0 tons of CO_2 per acre. Throughout the 100-year modeling period, emissions reductions would be generated more consistently, with only one 5-year period during which a minor emission would be projected to occur due to harvest activities removing slightly more carbon than is sequestered. The cumulative emissions reductions based on an averaged baseline would be 1,199,034 metric tons of CO_2, or 130.3 tons of CO_2 per acre, an amount slightly higher than what would be reported under the current Protocols (1,086,466 metric tons of CO_2).

Another benefit of calculating an average value for the baseline curve is it allows us to further parse the causes of the emissions reductions results. Since the initial CO_2 stocks (1,408,375 metric tons) are higher than the average baseline CO_2 stocks (1,013,246 metric tons), this 395,129 metric ton difference may be considered the avoided depletion of stocks that result from the project activity occurring on the Bascom Pacific Forest rather than the baseline activity. Thus, of the 1,199,034 metric tons of additional CO_2 sequestered by the end of the project lifetime, approximately 33 percent can be attributed to the avoiding the depletion of stocks that would have taken place if the baseline activities were allowed to occur. On the other hand, 67 percent of the total emissions reductions can be attributed to additional carbon sequestered as a direct consequence of the project activities.

Given that the baseline is an evaluation of a hypothetical without-project scenario, there are no real-world consequences in terms of additional CO_2 being removed from the atmosphere in one year and emitted the next year when such removals and emissions are "caused" primarily by changes occurring in the baseline activity. Thus, assuming the pattern of large fluctuations in the baseline scenario developed in this study would continue if the modeling period was extended indefinitely, it seems reasonable to calculate a steady-state baseline value based on the average stocking under the baseline scenario over the 100-year modeling timeframe. Using an appropriate steady-state value for the baseline curve would simplify emissions reductions accounting, eliminating confusion and producing a result that more accurately estimates the 100 year atmospheric benefits of the project. However, given that the potential emissions reductions that may be reported increased in this case when an averaged baseline was applied, more thorough evaluation may be necessary to ensure the appropriateness of accounting for emissions reductions in this manner. Further, the benefits of using an averaged baseline depend on the project actually extending for its anticipated 100-year lifetime. If a project is terminated prior to its 100-year lifetime the accounting of emissions reductions will be inaccurate unless the project average baseline were recalculated to the point of early termination and all previously issued emissions reductions were adjusted accordingly.

For a landowner selling emissions reductions, managing the fluctuating emissions reductions levels that are an artifact of the baseline forest management pattern would be very challenging. A buyer typically requires that the emissions reduction be permanent, so the period in which reversals occur due to forest regrowth prior to another regeneration harvest presents a problem. The seller would need to provide replacement emissions reductions or create another kind of arrangement with the buyer, perhaps "borrowing" against future years' reductions at a discounted value to account for the performance risk.

6.2 Wood Products

The inclusion of the wood products pool in calculating emissions reductions has the net effect of lowering the overall emissions reductions that would be generated by 14,176 tons of CO_2, by the end of the 100-year project lifetime (Table 16 and Figure 9), a decrease of 1.3 percent. Such a small decrease is due to the harvest volume under the project activity scenario being over 93 percent of the volume harvested under the baseline activity scenario. Considering the difficulties CACTOS and other growth models have with accurately projecting growth in managed older forests, it may be that the harvest volume projected for the project activity scenario is inaccurate. Thus, in reality the volume harvested under the project activity may be equal to or greater than the baseline activity harvest volume. As such, accounting for the wood products pool may prevent a decrease in cumulative emissions reductions at the end of the project lifetime and may even cause an increase in emissions reductions. Nonetheless, although projected emissions reductions are lower by the end of the project, the different rates and timing of harvest cause cumulative emissions reductions to be higher during the period 2046 to 2066. This reveals again that the end of project conditions do not reliably indicate conditions that may occur throughout the course of the project lifetime.

If the average value of the baseline curve is used to calculate emissions reductions, the projected emissions reductions are increased by 132,208 tons of CO_2, or 11 percent. Yet again, a comparison between emissions reductions with and without wood products during the 100-year project lifetime shows that cumulative emissions reductions are lower from project initiation through 2061 when accounting for wood products carbon, and then become higher and remain so through the end of the project lifetime. Thus, the inclusion of wood products has a more nuanced impact than simply raising or lowering the emissions reductions. This is especially true given the requirement of project developers to report their stocks and emissions reductions annually, and remeasure their stocks at least every 12 years. In the case of this project, accounting for wood products has the effect of minimizing the fluctuations in reported emissions reductions from year to year. However, as illustrated in Figure 9, this effect is not drastic since wood products generally account for a small percentage of the total difference between the baseline and project activity carbon stocks in any given year.

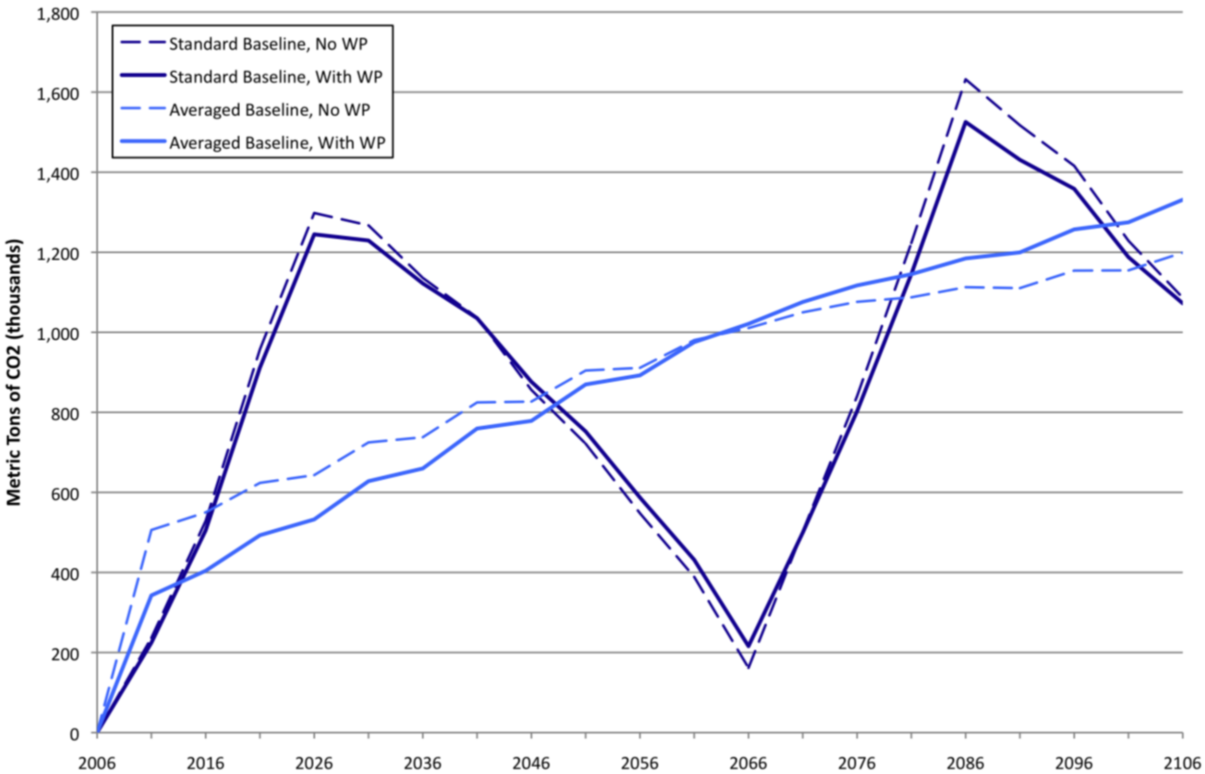

Figure 9. Cumulative emissions reductions over the 100-year project lifetime, using standard and averaged baseline values, and both with and without wood products pool stocks. The inclusion of wood products has the effect of decreasing the difference between the amount of emissions reductions generated from one period to the next.

6.3 2008 Project Stocks Monitoring

The remeasurement of live tree, standing dead tree and lying dead wood pools in 2008 indicated that carbon stocks within each pool and in total increased more than projected for the Bascom Pacific Forest over the two years since project initiation (Table 17). Overall carbon stocks were projected to increase by 12,108 metric tons of carbon over two years (3.2 percent), or 0.7 tons per acre per year. This increase was projected to be caused solely by changes to the live tree pool. Both the standing dead tree and lying dead wood pools were assumed to remain constant over the project lifetime. But the 2008 inventory estimated an increase in the live tree pool of 33,912 metric tons (9.2 percent), or 2.1 tons per acre per year, nearly three times the projected increase, while the standing dead tree and lying dead pools each increased by over

5,000 metric tons (163.4 percent and 43.8 percent, respectively), or 0.3 tons per acre per year. Assuming the 2006 and 2008 inventories provide an adequate basis for comparison, total carbon stocks increased by 11.6 percent, nearly four times more than projected, at a rate of 2.7 tons per acre per year.

These deviations from projected values can be attributed to several sources, six of which are addressed below. The degree to which each source contributed to the deviations observed can not be determined. First, activities that took place on the project site from 2006 to 2008 did not match the activities that were projected to occur. Project activity projections were based on a harvest rate of approximately 3,000 MBF per year in 2007 and 2008. But only about 10% of this amount was harvested from the project site. As a result, less carbon was removed through harvest and more was allowed accumulate than was originally projected, contributing to the increase in 2008 carbon stocks over the projected amount.

Second, as previously noted, the initial lying dead wood inventory did not fully comply with the measurement standards outlined by the Forest Protocols. The minimum specification used for length measurements (pieces ≥10 inches diameter inside bark at the large end) would not have captured all pieces that would have been captured if the inventory was in full compliance (pieces with an average diameter ≥6 inches). For example, a 10 foot long piece of wood that was 9 inches in diameter on the large end and 7 inches in diameter on the small end (i.e. average diameter of 8 inches) would not have been counted, although a significant number of lying dead wood pieces of similar dimensions could exist on a property that undergoes timber harvests on a regular basis, as is the case with the Bascom Pacific Forest. Thus, the 2006 inventory likely underestimated the amount of carbon in the lying dead wood pool, accounting for a portion of the increase in the lying dead wood stocks.

Third, the standing dead tree and lying dead wood pools were both assumed to remain constant over time. This is primarily due to the inability to model changes in either pool in a reliable manner. As a result, any measured changes in either pool would cause a deviation from projected stocks.

Fourth, each inventory was based on a slightly different measurement methodology. Although the measurement specifications used were in compliance with the standards outlined by the Forest Protocols (with the exception of the initial lying dead wood inventory), the cruise designs for the 2006 and 2008 inventories were slightly different. As a result, live trees, snags or pieces of lying dead wood of a certain specification may have been captured by the initial inventory but not by the 2008 inventory, and vice versa. For example, the initial inventory called for the tallying of up to only a certain number of trees below 4.6 inches DBH within regeneration sub-plots, whereas the 2008 inventory did not place a limit on the number of trees to be tallied in regeneration sub-plots.

Fifth, since both inventories are estimates based on the statistical expansion of sample measurements made on the project site, the sampling error associated with sample-based inventories contributes to uncertainty around each estimate. Even if the other sources of difference addressed here were eliminated, it would be highly unlikely that two sample-based inventories would produce exactly the same results. That being said, it is not possible—short of measuring all trees on the project site—to determine whether each inventory over- or underestimated the actual carbon stocks.

Finally, there is uncertainty (i.e. a degree of error) associated with model-based projections since the assumptions and parameters that serve as the basis for such projections do not reflect reality perfectly. This uncertainty comes into play twice for this project. The project activity projection has uncertainty associated with it. But the initial inventory has some additional uncertainty associated with it since all of the stands were inventoried prior to 2006 and then updated (i.e. growth was projected) to the project start date. As a result, the uncertainty associated with the initial inventory may compound the uncertainty associated with the project activity projections.

Regardless the causes, even though the project activity modeling underestimated the amount of emissions reductions that were generated through 2008, the Forest Protocols specify that emissions reductions are calculated for a given year by finding the difference between the baseline stocks and the reported stocks on the project site. Since a complete remeasurement of the project stocks took place in 2008, the emissions reductions for that year would be based on the difference between the project stocks from the new inventory and the baseline stocks. The initial project activity projections would have no bearing on the emissions reductions calculated for 2008. Thus, even though the emissions reductions through 2008 were projected to be 94,647 tons of CO_2, the actual emissions reductions that would be reported, and subject to verification, through 2008 are 213,438 tons of CO_2. Similar underestimations would be expected in subsequent years if there continued to be no harvest activities on the project site.

Of note, under the annual stock change accounting requirements of the Protocols, emissions reductions that would be reported and subject to verification in subsequent years would be only those above and beyond the 213,438 tons reported in 2008. For example, if the project developer estimated a total of 220,000 tons of CO_2 stocks on the project site in 2009, the reportable emissions reductions would be 6,562 tons of CO_2 (220,000 tons minus 213,438 tons).

7.0 Discussion of Application of the Forest Protocols

Overall, the results of the application of version 2.1 of the Forest Protocols appear to provide practical but rigorous accounting of emissions reductions to internationally acceptable standards. Nonetheless, there are a number of areas where we recommend changes to provide more efficient and accurate application, while still adhering to the desired level of rigor.[2] As the work on this paper progressed, the Protocol itself went through revision, with the result that some of our recommendations were subsequently incorporated to the new version 3.0. The following discussion incorporates our experience and recommendations for applying, clarifying and/or amending version 2.1 of the Forest Protocols, as well as some additional discussion of the implications of changes made in version 3.0 if these new provisions were applied to a project such as the Bascom Pacific Forest.

7.1 Carbon Stocks Inventory

The initial conditions inventory, when properly specified, can be cost effectively undertaken concurrent with a conventional timber inventory but does add expense. The greater expense is due to the generally higher statistical confidence required in sampling[3] and the inclusion of additional inventory elements such as standing and down dead biomass. Further, the requirement for permanent marking of plot centers is a costly variance from the standard timber inventory practice of temporary flagging. Version 3.0 of the Forest Protocols eliminates the requirement for permanent monumenting, while still requiring temporary flagging so that verifiers can locate plot centers. In addition to the specific requirements of different project types under the Protocols, inventory costs vary with the size and heterogeneity of the property, not unlike timber inventories. Larger more homogenous properties will cost less to inventory than the mid-size, relatively diverse Bascom Pacific property.

The use of the equations provided by Jenkins *et al*. (2003) to convert inventory data into carbon stock estimates appears to establish a decent estimation. However, the Jenkins equations are based on data from broad species groupings that are more appropriate for national or regional scale estimates of biomass and carbon rather than project scale estimates. For example, the equation used for ponderosa pine by the Forest Protocols is a generalized equation developed from 43 separate regression equations for 14 different species in the *Pinus* genus. Of those 43 regression equations, only 5 are representative of Ponderosa pine. Another example worthy of mentioning is the equation used in the Forest Protocols for coastal redwood/giant sequoia/incense-cedar. In this case, the generalized equation was developed from 21 different regression equations for roughly 9 different species across 6 separate genera. Of these 21 equations, only one is representative of giant sequoia and one is representative of incense cedar.

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[2] The hypothetical application of the Forest Protocols to the Bascom Pacific property undertaken in this Project confirms similar experiences of the Pacific Forest Trust in other projects developed under the Forest Protocols. Our discussion incorporates our experience and recommendations derived from these other projects as well.

[3] Lower sampling confidence intervals (i.e., greater than +/-5% at the 90% confidence interval)

No equations for coastal redwood were used to create the generalized equation representing that species in the Forest Protocols.

Furthermore, the only data the Jenkins equations use to estimate biomass is diameter at breast height. Although the use of the Jenkins equations may be adequate for national-level estimates or for a given project for which the Jenkins equations have been tested to ensure they produce accurate estimates for all species involved, there is often too much variability within an individual forest site and between forest sites to use a nationally generalized equation at the project level.

As a result of these generalizations, estimates of carbon stocks for a given project may be higher or lower than is truly the case. Whether the estimate is higher or lower than reality (as well as the how much higher or lower) depends on the exact species representation and tree sizes involved. Regardless, the United States Forest Service's Forest Inventory and Analysis (FIA) program have developed tree biomass equations that are species specific and are based on, at a minimum, the cubic foot volume of the bole, and often the diameter at breast height and height in order to calculate bark and branch biomass separately from bole biomass. Thus, the FIA equations are considered to estimate more accurately the true carbons stocks in a given forest. Indeed, version 3.0 of the Forest Protocols replaces the Jenkins equations with those used by the FIA.

7.2 Baseline Characterization

Using the guidance of version 2.1 of the Forest Protocol, the Baseline is not challenging to develop and model, given the relatively specific set of regulations under which forest practices are conducted in California. We note that in addition to the fact that version 2.1 of the Forest Protocols requires the use of Option C as the standard for modeling state level harvest volume regulation, as a property and ownership that is less than 50,000 acres in size, Option C is the specific sustained yield rule under which the Bascom Pacific is operated, therefore Option C forms the basis for state forest practice regulatory analysis under both version 2.1 and 3.0.

However, in a project such as Bascom Pacific where "business as usual" timber harvest can often be characterized by a series of clear-cuts and regrowth, we would recommend that the harvest regime modeled in the baseline produce a more balanced and regular flow of growth and harvest to more accurately represent the net baseline stores over the 100-year project; e.g., a series of clear cuts and intermediate treatments initially followed by intermediate treatments and selection harvests, as feasible legally and financially. As discussed earlier, removal of the large fluctuations that are derived from the repeated pattern of high intensity removal and subsequent regrowth simplifies the accounting of resulting emissions reductions without sacrificing long-term accuracy.

Even with this approach to characterizing the Baseline, we believe the use of an averaged baseline in version 3.0 against which annual stock changes are measured represents a significant improvement, given the management and accounting implications inherent in silvicultural cycles, described earlier.

7.2.1 Accounting implications of an averaged Baseline in the event of early project termination

We note that the use of an averaged baseline could in some circumstances present a challenge to the accuracy of the whole accounting system set up in the Forest Protocols if early termination of a project occurs (i.e., intentional termination prior to the 100-year project lifetime). The potential inaccuracy of project accounting could cast a shadow of uncertainty and impermanence on the whole system absent appropriate measures to mitigate for over-crediting that could occur. If a project were terminated prior to the average stocks for the actual project period equaling the averaged Baseline stocks for the 100-year intended project lifetime, the registered emissions reductions could be materially higher or lower than they would be if the baseline had not been averaged. For instance, in a project where the forest is relatively young, the baseline activity would include a period of growth to merchantability that extends 10 to 40 years from the date of project initiation. In this instance, baseline stocks prior to averaging would reflect such business as usual growth until the conditions when timber harvest would legally and financially be feasible. With the use of an averaged baseline, the average stocks for the baseline could be lower than the non-averaged baseline projection for this period, leading to over-crediting of emissions reductions. To address the potential inaccuracy in the measurements of a project that is terminated early, version 3.0 of the Protocol requires a greater than 1:1 replacement value on a schedule that declines from 1.4 to 1.0 to fund reversals in the first 50 years of the project.

7.2.2 Use of a "Common Practice" metric to better assure conservative estimates of emissions reductions in the case of avoided depletion of carbon stocks

One area of concern that we have encountered in developing and reviewing some emissions reduction projects under version 2.1 is whether the depletion of standing live carbon stocks could be exaggerated in a Baseline methodology that only uses an explicit regulatory test. Some observers feel that the result of actual forest practices on the ground have produced higher average carbon stocks than would be generated through the application of the version 2.1 baseline methodology. Version 3.0 addressed this matter by adding the financial feasibility test (previously considered implicit by some practitioners) and by adding the Common Practice standard below which above-average carbon stocks could not be depleted.

The implication of these changes is not fully understood yet due to the lack of experience in the application of the more complex Baseline methodology of the new version. Further, simple comparisons using existing data are rendered difficult by other changes to the Protocol, including new assessments and adjustments for leakage, differences in accounting for harvested wood products, and overall measurement differences due to the switch to the FIA biomass equations. While it is beyond the scope of this paper to completely remodel the Bascom Pacific project under the new requirements, we compared the FIA mean live carbon stocks for the Southern Sierra Nevada – Southern Cascades Assessment Area in which the project resides, as identified in version 3.0 (39 mt C/acre) with the starting live carbon stocks indicated in the 2006 inventory (40 mt C/acre) to determine if there would still be the ability to account for the avoided depletion of this relatively well stocked commercial forest. While the starting stocks are above the Common Practice metric selected by the Reserve, the new baseline would permit only one mt C/acre (or 3.67 mt CO_2/acre) or a total of approximately 30,500 mt CO_2 total for the project to be credited toward issuance of CRTs. While under version 2.1, the baseline averaged 30 mt C/acre, overall crediting for avoided depletion under version 3.0 would be limited to the higher level of 39 mt C/acre. The results estimated here are quite tentative; nonetheless, they suggest that the emissions reductions attributable to the avoided depletion of standing carbon stocks could be reduced by about 90%. We also prepared rough estimate of the impact of the new Common Practice limit on crediting for avoided depletion of a well stocked redwood forest which suggested a reduction of 50% under version 3.0 vs. version 2.1.

Such a significant difference in accounting for avoided depletion of well-stocked stands adopted in version 3.0 of the Forest Protocol raises a number of policy and statistical questions that we believe require further review and analysis. We note that all carbon accounting is driven by policy goals, e.g., to encourage measurable and verifiable reductions in GHG emissions through a range of activities, which for forests, include avoiding the loss or depletion of existing forest carbon stocks. As to the latter project activity, the first question arises, what is the appropriate Baseline reference point against which conservation of the existing stores in a carbon rich older forest is benchmarked? The next question is, given a particular Baseline methodology, would the level of calculated emissions reductions awarded be sufficient incentive for a forest owner to undertake the project and make an enforceable commitment to avoiding the depletion of the forest to the extent permitted by law and rewarded by the marketplace? While some feel that only one or the other of these two questions needs to be satisfactorily answered, we believe both do if we are to gain participation in development of emissions reductions projects and make headway against the market forces that have made forest loss and depletion the second greatest source of excess CO_2 in the atmosphere.

The stakeholder work group that developed much of what is contained in version 3.0 of the Protocol had a similar discussion in regard to encouraging participation among forest owners who have forests with carbon stocks below the Common Practice level: Should these owners be required to grow their stocks to at least the FIA live stocks mean in order to receive credit? The majority of the work group believed that this would severely limit participation so the policy judgment was made to allow credit for sustained increases in stocks from a specified Baseline level regardless of whether those stocks would ever increase to the Common Practice level for the relevant Assessment Area. By this and other examples we can see that the rules for emissions reductions accounting are driven by policy goals that are then supported by using scientifically grounded measurement and other criteria to assure conservative quantification.

Another concern we have with the use of the FIA mean live carbon stocks as the metric that represents Common Practice is whether the reference population of plots is correctly defined and statistically sufficient. The plot data used for version 3.0 comprises all private forestland, whereas the project type is for managed forests. Common Practice among commercially managed forests has tended to drive inventory levels down toward an economically optimal level that in our experience tends to be less than the Common Practice metrics presented in version 3.0. This may be due to inclusion of data from private forests that are voluntarily or legally reserved from harvest, potentially skewing the mean upward with the inclusion of these "uncommon" forests in the defined population. Further, it is arguable that the mean is the appropriate reference point for avoided depletion at all as the majority of the landscape may have lower stocking levels, but small pockets of older forest pull the average upward for the region. These anomalous older forests are just the ones that are most at risk of depletion, so it is reasonable to suggest they not be compared to a number that includes them, but rather to the business-as-usual managed forest landscape shaped by market forces. The question of statistical sufficiency speaks to whether there are adequate plots representing the appropriate population from which to generate a reliable estimate of live carbon stocks. The quality of the FIA data varies from state to state and eco-region to eco-region.

7.2.3 Application outside of California

The Baseline methodology utilized in the Forest Protocols could be applied outside of California fairly readily. This would require characterizing the regulatory threshold prevailing in the jurisdiction in which a project is located; however this characterization is performed in timber appraisals routinely used to value and transact tens of millions of acres of timberland across the country. Further, using appraisal standards for baseline characterization would assure that Baseline conditions represent not only legally binding limits such as regulations or pre-existing title encumbrances, but also address the physical and financial feasibility of the activities. Version 3.0 incorporates both a regulatory and financial feasibility test to enable Baseline development in jurisdictions across the U.S. As the first project is developed in any new forest type and jurisdiction, there will be considerable effort required to conservatively characterize and justify the Baseline assumptions for business-as-usual activity. We also note that the FIA data-set nationally is not seamless and varies in its consistency and intensity of sampling. This may present problems for the use of the FIA mean as the Common Practice benchmark when projects are developed in various parts of the country.

7.3 Project Activity Modeling

While it is appropriate to verify the Project projections once at the initial Project Certification (absent material changes in inventory data), in practice, we note that the use of modeling to project emissions reduction from Project activity only provides very generalized guidance for potential emissions reductions unless the Project model is well-maintained and updated over time. Indeed, project activity projections play an important role in helping to manage the disposition of emissions reductions by placing short-term emissions reductions generated by the project within the context of the long-term emissions reductions profile forecast for the project. Thus, project developers (with projects registered under version 2.1 of the Forest Protocols) can then limit the sales of emissions reductions generated early during the project lifetime in order to ensure that enough emissions reductions are maintained to cover any anticipated future reversals (e.g., those caused by fluctuations in the baseline). To be an on-going management tool, the model results need to be recalibrated by project owners over time to reflect actual timber harvest, other forest management activities and the inevitable differences between modeling and actual inventories that will arise over time.

7.4 Harvested Wood Products

As discussed above, the inclusion of harvested biomass transferred to wood products increases the realism of the accounting generally, but lacks the same degree of rigor that is required of the other carbon pools. There are great uncertainties associated with tracking and measuring wood products along the chain of custody. Furthermore, accounting of indirect or secondary emissions of wood products in use is wholly lacking. We believe that even the accounting methodology in version 3.0 Forest Protocols needs further refinement to better incorporate these uncertainties and emissions associated with the manufacture, transport and use of wood products. While some argue that it is better to over-estimate the continued stores in wood products so as to err on the side of conservative calculations of emissions reductions, we believe that accuracy in accounting should be improved to the greatest degree possible at the project level.

In version 3.0 of the Forest Protocols the potential additional transfer of some amount of carbon from harvested wood products into landfills after discard is included in the wood products accounting methodology only when less wood is being harvested in the project than in the baseline case. The rationale for this is to produce a more conservative estimate of emissions reductions. We are leery of including any estimate of long term stores in landfills given several factors: landfill data is of poor quality; the powerful methane emissions from landfills are not incorporated into the estimates of carbon stores to calculate net greenhouse gas emissions; there are issues of control and ownership of the carbon in landfills; and the fate of wood discarded after use is shifting rapidly due to public policies and programs promoting recycling, composting and biomass energy. This is an example of an instance where, the Reserve chose a methodology that produces a more conservative result, but which may also yield a less accurate one.

Inclusion of harvested wood products in the accounting for forest management projects is in most cases not likely to have a significant impact on long term emissions reductions calculated for most such projects, as described in more detail above. In most, even with a focus on conserving and restoring on-site carbon stocks through changed forest management intensity and timing, the primary change that the addition of wood products to baseline and project calculations tends to be to the timing of timber harvest and less to the volume. Therefore the timing of emissions reductions changes more than the volume, which may be minimized with the use of an averaged baseline.

7.5 Permanence

The range of risks to Permanence, combined with other project risks (market, regulatory, verification, measurement variability, etc.) are critical to acknowledge and seek to mitigate, especially considering the long-term nature of the project commitment. Since the Forest Protocols are young and project history extremely short, potential losses cannot be estimated reliably. Regardless of the requirements of the Forest Protocols, project owners are well served to hold back a loss reserve of at least 10% of annual registered emissions reductions, as either unobligated or not transferred to others, to self-insure against the range of risks to the permanence of registered emissions reductions (this would be prudent even if, under the risk assessment in version 3.0, a project were to have its Buffer Pool contribution calculated at a lower level)

We also note that the Permanence of a Project depends on ensuring consistency in Project activity during a very long period over which the likelihood of at least one ownership change grows substantially. Therefore, the use of multiple legal instruments to mitigate risks to permanence from ownership and management changes would provide the greatest assurances for the longevity of registered emissions reductions. In particular, in addition to the requirement of an explicit contract with the Reserve that provides for clear remedies for breach, as included in version 3.0 of the Forest Protocols, the use of a conservation easement has significant added value for prevention of over-harvesting or development-driven loss of carbon stocks in the event of involuntary transfers. As described above, conservation easements also ensure additional carbon stores are more likely to be retained in a genuinely permanent manner, above and beyond the 100-year Project Lifetime. Their grant to a conservation entity provides an independent, permanent level of monitoring of land use restrictions that form the basis of project activity in most forest management based projects.

7.6 Certification

One key aspect of project development under the Forest Protocols that is not addressed in this study is the Certification (*a.k.a.* verification) process. Therefore, we will simply note that this is the greatest on-going requirement and expense of Reserve projects. The independent certification process provides assurances to the Reserve, purchasers of emissions reductions and the public as to the reality of registered emissions reductions. The process also can provide helpful guidance for participating landowners and promote on-going improvements in the overall accounting system. However, it should be noted that certification represents a risk to landowners as well, as certifiers must sign off on project accounting prior to the Reserve's acceptance and registration of emissions reductions. Landowners could be subjected to expensive, burdensome certification processes and inconsistent interpretations of the Forest Protocol's requirements absent greater efforts to provide clear certification policies and procedures, as well as guidance for interpretation of the Forest Protocols. The new version of the Forest Protocols helps address some of these concerns, providing for field verification at 6-year intervals after the initial verification, and desk verification of annual stock change reports in intervening years, allowing for market delivery of verified emissions reductions in a more cost effective manner.

7.7 Entity Level Reporting

In addition to project level reporting, which has been the focus of this study, under version 2.1 of the Forest Protocols project developers are required to report their stocks at the entity level, which includes their biological and non-biological emissions, including project and non-project related activities alike. The intent of this requirement is to help entities to understand better their full greenhouse gas emissions profile, as well as to help prevent certain forms of activity-shifting leakage from occurring. If a project developer were to decrease harvest rates on some of his or her forestland as a part of planned carbon project activities but were to increase the rate of harvest on the remainder of his or her forestland, the emissions reductions reported for the project would be displaced by the increased emissions resulting from higher harvest rates on the project developers non-project land. Entity-level reporting would reveal the diminution of the project-level emissions reductions that would be caused by this form of leakage.

In the case of the Bascom Pacific Forest, entity-level reporting is rather simple due to two conditions. First, the project site constitutes the entire acreage of the lands owned by the entity that would be reporting and registering the project. As a result, entity-level biological stocks are identical to project-level stocks and would be reported as such. Second, the entity that owns the project site does not actually manage the land, nor does it own any equipment associated with management of the land, including logging equipment or mills. Rather, a forest management firm manages the land on behalf of the entity and the logs harvested from the project site are sold to a mill owned by a different entity. Thus, the project developer would not be required report any non-biological emissions as a part of entity-level reporting since all non-biological emissions associated with the project are owned, and would thus be reported by, a different entity.

Since these conditions exist for the entity that owns the Bascom Pacific Forest, only biological emissions (or carbon stocks in this case) for the project site would be required to be reported in order to fulfill entity-level reporting obligations.

7.8 Costs and Returns of Undertaking a Forest Project

When a landowner undertakes a project under the Forest Protocols, they are, in effect, entering a new business, producing certified emissions reductions. As with any forest product, emissions reductions have their costs and returns. Any landowner considering the development of a forest project should carefully consider the long-term commitment of resources, the current novel and unpredictable nature of the carbon market and the potential financial returns.

We conducted a pro forma financial analysis of the hypothetical Bascom Pacific project presented here and this analysis indicated an increase in net present value (NPV) from the net proceeds of the project of approximately $4 million or $435/acre.

The assumptions used in this analysis were:

1. Periodic emissions reductions were calculated using the "averaging" method to smooth out the fluctuations between reductions and reversals, so as to more accurately represent the results of how a final project would likely be developed for registration under either Protocol.[4]
2. 10% of emissions reductions were held back for a loss reserve or self-insurance
3. Emissions reductions were transacted at $9/mtCO_2e$ (representative of with 2008 – 2009 market pricing) with this price held constant for the 100-year lifetime.
4. Verifications were estimated at $75,000/5-year period, incorporating one field verification and four desk reviews.
5. Other costs for initial project monitoring, Reserve documentation, and project management were estimated at $50,000 initially and $25,000 for subsequent periods
6. Cost of sales was estimated at 5% of sales receipts

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[4] We note that in the event that the Baseline was recast under version 2.1 as described on page 56, there would still be a period of reversals as the forest regenerated after the initial series of clear cuts. This would be handled, as is the case in the actual Van Eck Forest Project, by the landowner holding back a portion of the first 25 years' verified emissions reductions from the market to serve as a bank to fund the subsequent reversals. Regardless, the net emissions reductions at the end of 100 years are the same.

7. A discount rate of 15% was applied to the net earnings stream for the 100 years

Given the early stage of both the application of the Forest Protocols in actual projects and the carbon market, these assumptions are based on limited data and experience, and are therefore relatively speculative, as reflected in the discount rate applied. It is our hope that with wider application, and more efficiency gained throughout (but in particular in the certification process), these assumptions could prove conservative.

On balance, after reviewing the results of the hypothetical Bascom Pacific Forest project, and comparing them to other projects under the Forest Protocols with which we are familiar, we believe that the potential financial returns from such projects could provide an incentive for landowner participation, while fostering long term forest conservation and significant net gains from long term reduction of CO_2 emissions. We note that larger projects will likely have savings of scale as compared to smaller projects, especially in regard to project development and inventory costs. The Love Creek Forest is the smallest project developed under version 2.1 of the Forest Protocols with which we are familiar. It is about 350 acres and it, too, projects a modest but net positive financial return for the landowner under similar revenue and cost assumptions. Nonetheless, we believe that the Reserve should seek to develop a scheme whereby landowners of smaller properties could formally collaborate in registering projects, while still meeting the rigorous measurement and quantification requirements of the Forest Protocols.

In closing, we note that the Climate Action Reserve's Forest Protocols have been and will continue to evolve as developers, landowners, verifiers, the Reserve and policy makers apply them and learn from the results. Given the novel challenges presented by climate change and the urgent need for action to address them, we believe it is reasonable and appropriate to move ahead with emissions reduction projects under the prevailing state of the art with an understanding that it will incorporate improvements through an iterative public process, rather than wait for a theoretical perfect system before taking action.

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9.0 Glossary

C	Carbon
CACTOS	California Conifer Timber Output Simulator
CO_2	Carbon dioxide
DBH	Diameter at breast height
FIA	Forest Inventory and Analysis program of the USDA
GHG	Greenhouse gas
mt	Metric tons
MBF	Thousand board feet
PFT	Pacific Forest Trust
PIA	Project Implementation Agreement
WESTCARB	West Coast Regional Carbon Sequestration Partnership