



Hollow Tree Project

Offset project Data Report

Version 1.6, 4/17/2017

Revised 6/07/2017

Improved Forest Management Projects on
Private Land

Air Resources Board

Compliance Offset Protocol – U.S. Forest
Projects

Adopted November 14, 2014

Mendocino Redwood Company
Hollow Tree Project
Improved Forest Management

Offset Project Operator:

Mendocino Redwood Company

P.O. Box 996

Ukiah, CA 95482

Tel: (707) 463-5125

Email: **sbillig@mendoco.com**

Reporting period:

The reporting period for this Offset Project Data Report is 12.25 months (6/4/2015 – 6/13/2016).

Protocol Version:

Air Resources Board

Compliance Offset Protocol – U.S. Forest Projects

Adopted: November 14, 2014

Note to the reader regarding differences between the OPDR and listing documents

There are significant differences between the listing documents and this OPDR as a result of updating information. The changes between the listing documents are enumerated in the following table.

Item #	Item	Location in OPDR	Listing information provided	OPDR
1	Project Acreage	Section 3.4	20,295	20,300. Minor corrections to project boundaries
2	Inventory Methodology	Section 4	Separate document "Carbon Project Inventory Methodology" included by reference.	Additional detail provided with respect to plot selection, vegetation type sub classes, acres by vegetation type, consolidation to inventory strata, plot navigation and monumentation, and tree measurements.
3	Quantification Methodology	Section 4.6	Separate document "Carbon Project Inventory Methodology", included by reference.	Additional discussion regarding volumetric corrections for trees with broken tops
4	Inventory Updates	Section 4.7	Separate document "Carbon Project Inventory Methodology", included by reference.	The discussion of inventory updates was revised.
5	Diseases	Section 4.8	Separate document "Carbon Project Inventory Methodology", included by reference.	This discussion was moved into the body of the OPDR.
6	Description of legal constraints affecting forest management	Section 5.1	In a separate document "MRC's carbon offset modeling plan".	Incorporated into the body of the OPDR.
7	Financial feasibility analysis	Section 5.2.1	Best estimate was completed at listing, but actual baseline model not completed.	The OPDR version uses outputs from the baseline model.
8	Description of financial feasibility of the baseline scenario	Section 5.2.1	Provide evidence of similar activities.	Financial feasibility analysis incorporated into the body of the OPDR.

9	Common Practice Statistic	Section 5.3.1	Information not available at listing.	Added to the OPDR following completion of the site index analysis
10	Baseline modeling plan	Section 5.3.3	Provided as separate document at listing.	Discussion has been moved into the body of the OPDR; revised methodologies for treating legal constraints, incorporating site index, and silvicultural methods.
11	Description of modeling techniques to simulate the effect of constraints	Section 5.3.3	In a separate document "MRC's carbon offset modeling plan".	Incorporated into the body of the OPDR.
12	Carbon in harvested wood for the baseline	Section 5.3.4	Information not available at listing.	This was added to the OPDR following completion of the baseline modeling.
13	Above ground live carbon stock	Section 6.1	Information not available at listing.	This was added to the OPDR following completion of the inventory and data processing.
14	Estimated adjusted above ground live carbon stock	Section 6.1	Information not available at listing.	This was added to the OPDR following completion of the inventory and data processing.
15	Carbon stocks by pool	Section 6.1	This information was not available at listing	Project carbon stocks by pool has been added; summarized in Table 14

Table of contents

Contents

1. Introduction	2
2. Ownership Interest	2
3. Project Eligibility.....	3
3.1 Statements and Attestations (Forest Offset Protocol §2.1, §9.1.1.1 (8) (9) (10) (18); §9.2.1(4) (5) (8) (9) (15) (17)).....	3
3.2 10% canopy cover (Forest Offset Protocol §2.1.2; §9.1.3(1)).....	4
3.3 Project Location and Project Area (Forest Offset Protocol -§4; §9.1.1.1 (15)(17))	4
3.4 Assessment area within Project Area (Forest Offset Protocol §9.1.1.1(16))	7
3.5 Additionality (<i>Forest Offset Protocol §3.1.2</i>)	8
3.6 Project Offset Commencement (Forest Offset Protocol §3.2; §9.1.1(7)).....	8
3.7. Sustainable Harvesting Practices (Forest Offset Protocol §3.8.1; §9.1.1.1(13)).....	8
3.8 Natural Forest Management (Forest offset Protocol § 3.8.2 – Table 3.2; §9.1.1.1 (14); §9.2.1 (10))	8
3.9 Ongoing management activities (Forest Offset Protocol, Section 5; §9.1.1.1(5))	11
4. INVENTORY METHODOLOGY	11
4.1 GHG Assessment Boundary (Forest Offset Protocol Section 5; §9.1.1.1 (19))	11
4.2 Inventory Design and Sampling Process	11
4.2.1 Stratification.....	12
4.2.2 Stratification Rules	12
4.2.3 Plot location	17
4.3 Cruise design	17
4.4 Plot monumenting and measurements	18
4.5 Data management system	31
4.6 Quantification methodology.....	32
4.6.1 Converting inventory data into carbon (IFM-1 and IFM-3).....	32
4.7 Inventory updates	34
4.8 Known or Potential Diseases.....	35
5. Baseline Carbon Stocks	35
5.1 Legal Constraints (Forest Offset Protocol §6.2.1.2; Appendix B.3; §9.1.1.3(4))	35
5.2 Consideration of Financial Constraints (Protocol § 6.2.1.3; § 9.1.1.3 (5))	35

5.2.1 Baseline financial assessment.....	35
5.2.2 Conclusion – baseline financial feasibility.....	37
5.3 Estimating baseline onsite carbon stocks (Private Lands) (Forest Offset Protocol, § 6.2; § 9.1.1.1 (21); § 9.2.1 (13)).....	37
5.3.1 Step 1 – determine the Common Practice value of above-ground standing live carbon stocks in the project area.....	38
5.3.2 Step 2 – determine if the Project Area’s initial above ground standing live carbon stocks are greater than or less than Common Practice (Forest Offset Protocol § 9.1.1.3 (2)).	38
5.3.3 Step 3 and Step 5 – Determine baseline above-ground standing live carbon stocks and all onsite carbon pools.....	40
5.3.4 Description and estimate of the Forest Project’s baseline onsite carbon stocks.....	47
5.4 Updating inventory and carbon stocks (Forest Offset Protocol § Appendix B.3; Forest Offset Protocol §9.1.1.1 (21)).	50
5.5 Determination of Minimum Baseline Level (Forest Offset Protocol § 6.2.1)	50
5.6 Estimating baseline carbon in harvested wood products (Forest Offset Protocol § 6.2.3).....	50
5.7 Quantifying secondary effects (Forest Offset Protocol § 9.2.1 (14)).	51
6. Project Carbon Stocks	51
6.1 Actual onsite carbon stocks	51
6.1.1 Inventory Confidence Statistics (Forest Offset Protocol §9.1.1.1 (24)); §9.2.1 (7)).....	52
6.2 Estimate of Harvest Volumes and Associated Carbon in Harvested Wood Products (Forest offset Protocol §9.2.1 (11) (12)).	53
6.3 Promotion of onsite carbon stocks (Forest offset protocol §3.8.3).....	53
6.4 Projections of Baseline and Actual Harvest Volume from Project Area over 100 year period (Forest Offset Protocol § 9.2.1 (20))	54
7. Calculation of GH reductions and removals (Forest Offset Protocol §9.2.1 (16) (19))	54
8. Reversal Risk Rating (Forest Offset Protocol § 7, Appendix D; (27) § 9.2.1 (18); § 9.1.1.1 (27); § 9.2.1 (18)).....	55
8.1 Reversal Risk Rating by Category	55
8.2 Project Reversal Risk Rating (Forest Offset Protocol § 9.1.1.1 (27); § 9.2.1 (18))	56
Key References.....	56

List of Tables

Table 1 Offset project information (Forest Offset Protocol § 9.1.1.1 (1), (2), (4); § 9.2.1 (1), (2), (3))).....	2
Table 2 Statements and attestations for the project.	3
Table 3 ARB site classes for the northern California Coast, Coast Redwood/Douglas-fir Mixed Conifer assessment area.....	6
Table 4 Native species percentage within the project area.....	9
Table 5 Planning watershed and acres less than 20 years old.....	10
Table 6 Acres in Hollow Tree vegetation strata for the project area.....	16
Table 7 Final inventory strata for the Hollow Tree project area.....	16
Table 8 Financial input variables for financial feasibility analysis of baseline model for project area.....	36
Table 9 Common Practice Statistic Calculation for the Hollow Tree project.....	38
Table 10 Weighted average above-ground live MTCO ₂ e for the Project Area.....	39
Table 11 Management Codes used for baseline modeling.....	42
Table 12 Baseline prescriptions assigned to management codes.....	43
Table 13 Description of baseline prescriptions used in baseline modeling.....	44
Table 14 Silviculture treatments modeled in the baseline scenario.....	46
Table 15 Baseline results show 100 year average of above ground carbon stocks equal the Minimum Baseline Level.....	49
Table 16 Average carbon stored in wood products and landfill over 100 years (Forest Offset Protocol §9.1.1.1 (26))).....	50
Table 17 Summary of inventory stocks for each pool at the end of the reporting period for Hollow Tree project (Forest Offset Protocol §9.1.1.1 (23); §9.2.1 (6)).....	51
Table 18 Inventory summary statistics by strata for the project area at the end of the reporting period.....	Error! Bookmark not defined.
Table 19 Net conifer harvest volume delivered to the mill (MBF scribner) during the initial reporting period.....	53
Table 20 Calculation of GHG removals based on COP Improved Forest Management worksheet calculated for project area.....	54
Table 21 Calculation of reversal risk for project area and buffer pool contribution.....	56

List of Figures

Figure 1 Map depicting project area boundary.....	5
Figure 2 Determining vegetation size classes for stratification in the project area.....	13
Figure 3 Down log ploy layout and measurement protocol for project area carbon sampling...	28
Figure 4 Accumulated gross revenues, net revenues, and costs for the project area under the baseline scenario.	37
Figure 5 Baseline carbon stocks for all required carbon pools on the project area.	48
Figure 6 Baseline Average Carbon Stocks by Pool. Captions: AGLC = Above-ground live; SDC = Standing dead; BGC = Below-ground; HWP- <i>iu</i> = Harvested Wood Products in use; HWP- <i>lf</i> = Harvested Wood Products in landfills.	49

1. Introduction

The Mendocino Redwood Company, LLC (MRC) Hollow Tree forest carbon project (Hollow Tree) is an Improved Forest Management (IFM) project developed under the California Air Resources Board Compliance Offset Protocol – U.S. Forest Projects. The Hollow Tree project is on forestlands owned in fee by MRC in Mendocino County, California.

MRC has owned the forestlands in the project area since its inception in 1998. The project area forests are dominated by redwood, Douglas-fir, and tanoak. Since 1998, MRC has been working to actively increase conifer and carbon stocking on these forestlands. Management of these forestlands is designed to increase conifer and carbon stocking while harvesting saw logs sustainably.

2. Ownership Interest

(Forest Offset Protocol §2.2, §9.1.1.1(3), Regulation §95974)

MRC is the owner in fee of the real property included in the Hollow Tree project, which includes interest in the trees and timber on the property. As the single owner of the real property, MRC is the Offset Project Operator with the legal authority to implement the offset project.

Table 1 Offset project information (Forest Offset Protocol § 9.1.1.1 (1), (2), (4); § 9.2.1 (1), (2), (3))).

Offset project name (Forest Offset Protocol § 9.1.1.1(1); 9.2.1 (1):	Hollow Tree Project
ARB project ID#	CAR1191
Offset Project Commencement	June 4, 2015
First reporting period start date (Forest Offset Protocol § 9.2.1 (3)):	June 4, 2015
First reporting period end date (Forest Offset Protocol § 9.2.1 (3)):	June 13, 2016
Offset project type (Forest Offset Project § 9.1.1.1 (4)):	Improved Forest Management
Professional Forester	Dennis Thibeault
OPO Project Contact	Sarah Billig
Contact email and telephone #:	sbillig@mendoco.com/707-463-5125
CITTS Account Number:	CA1942
OPO Mailing Address:	PO Box 996, Ukiah, CA 95482
Authorize Project Designee:	Not applicable

3. Project Eligibility

3.1 Statements and Attestations (Forest Offset Protocol §2.1, §9.1.1.1 (8) (9) (10) (18); §9.2.1(4) (5) (8) (9) (15) (17))

Table 2 includes statements and attestations by the OPO that meet requirements in sections 2.1, 9.1.1.1, and 9.2.1 of the Forest Offset Protocol.

Table 2 Statements and attestations for the project.

Forest Offset Protocol Section	Statements and Attestations
§9.1.1.1 (6)	The offset project occurs on private lands. The project does not occur on land that is owned by , or subject to an ownership or possessory interest of a Tribe; Indian lands of a Tribe as defined by 25 U.S.C. Section 81(a)(1); or land that is owned by any person, entity, or Tribe, within the external borders of such Indian lands.
§2.1.2; §9.1.1.1 (8)	The lands covered in the Project Area have never been registered with an offset project registry or program in the past. The lands contained within this area were listed within a larger carbon project previously listed with the Climate Action Reserve as CAR758 that was cancelled on August 5, 2015, prior to initiation of verification activities. No greenhouse gas emissions reductions or removal enhancements associated with lands within the Project Area have been credited or claimed for the purpose of greenhouse gas mitigation or reduction goals, whether in a voluntary or regulatory context. Since no GHG emissions reductions or removal enhancements have been credited within the Project Area, there are no vintages to report.
§9.1.1.1 (9)	This project is not being implemented or conducted as the result of any legally binding mandate (law, statute, regulation, court order, etc).
§2.1.2; §9.1.1.1 (10)	The project does not employ broadcast fertilization.
§9.1.1.1 (18)	The project will not employ a Qualified Conservation Easement.
§9.2.1 (4)	The project lands are in compliance with all local, state, and federal regulatory requirements during the reporting period.
§9.2.1 (5)	The information submitted for the project listing is not accurate. A change log related to the listing information is provided in the preface to this report.
§9.2.1 (8)	The project reporting period is less than 2 years. The 10-year consecutive period decrease in standing live pool is not applicable.
§9.2.1 (9)	The status of the forest owner has not changed.

§9.2.1 (15)	This is an Improved Forest Management Project so this requirement is not applicable.
§9.2.1 (17)	This is the first reporting period so no reversal has occurred.

3.2 10% canopy cover (Forest Offset Protocol §2.1.2; §9.1.3(1))

" The offset project takes place on land that has greater than 10 percent tree canopy cover" (Section 2.1.2, page 10)." MRC does not calculate average canopy cover as a part of its inventory process; however, a review of aerial photos demonstrates that MRC's timberlands are well stocked and meet the requirement of greater than 10 percent tree canopy cover in the project area.

3.3 Project Location and Project Area (Forest Offset Protocol §4; §9.1.1.1 (15) (17))

The project takes place on land located in the United States. Figure 1 depicts the location of the project. The Mendocino Redwood Company Hollow Tree project is located in Mendocino County in California; no towns are located within the project area. Hollow Tree Creek runs roughly through the middle of the project area. Non-forested areas greater than 10 acres were excluded from the project area. The project is located in the Township, Ranges, and portions of Sections noted below – all in the Mendocino Base Meridian.

Township and Range	Sections
T23N R17W	20, 21, 26-36
T23N R16W	31
T22N R17W	1-17, 21-27, 35-36
T22N R16W	6-7, 19, 30-31
T21N R17W	3

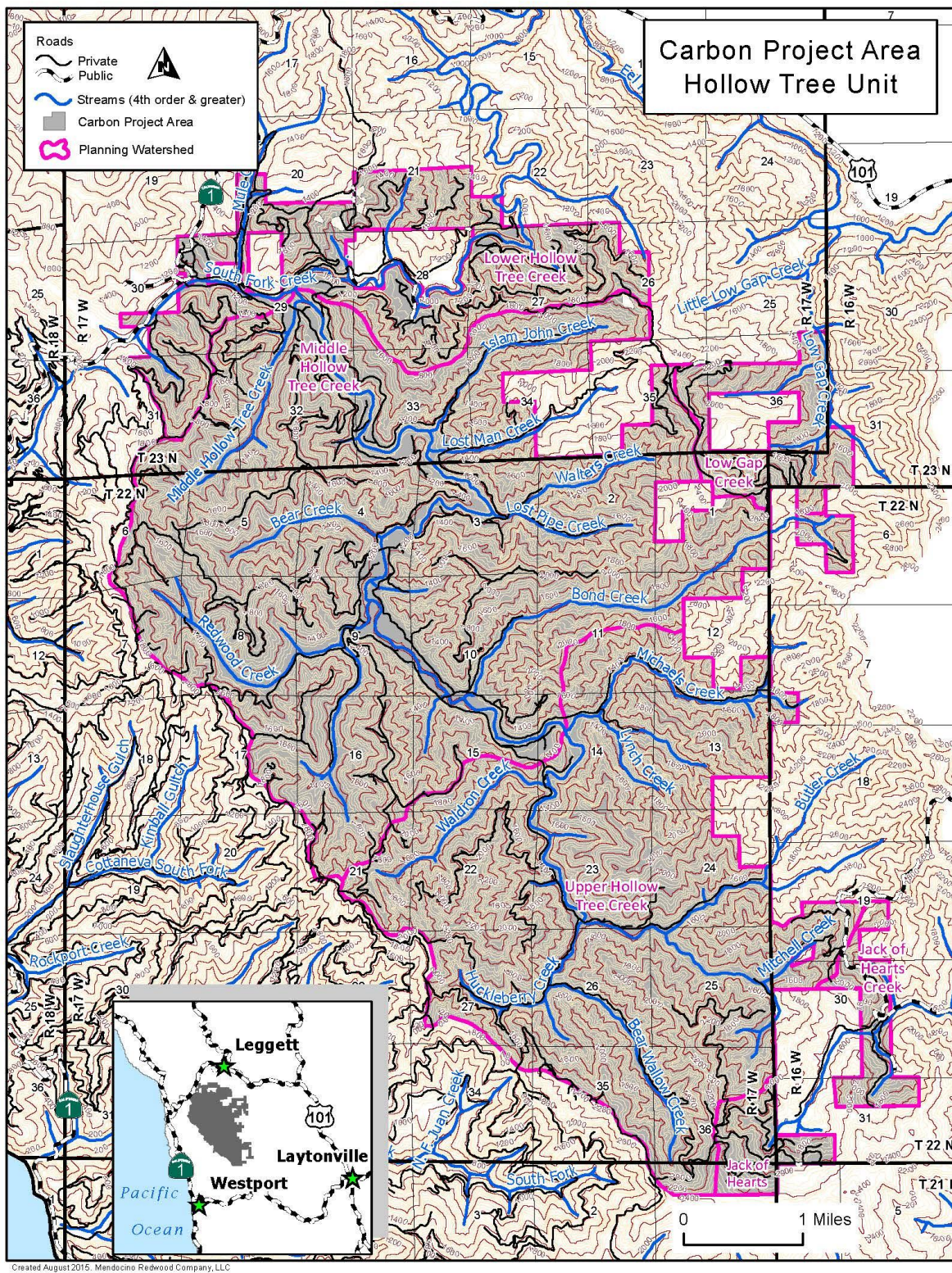
The following is the latitude and longitude of the project area (Figure 1):

Latitude of Offset Project

39 degrees 46' N

Longitude of Offset Project

123 degrees 44' W



Existing land cover and land use

Land cover within the Project Area is composed mainly of redwood-Douglas-fir forests with a tanoak component in these stands. Hardwoods stands are a limited component but do occur in areas with lower site qualities (i.e. rocky slopes). The Project Area is used mainly for timber harvesting and forest management; but is also utilized for limited hunting and recreational activities. Surrounding forest lands have historically been used for timber harvesting, ranching, and other rural land uses. It is projected that such use will continue into the future.

Forest management within the project area is aimed towards developing a multi-age forest stand that can be harvested using uneven-aged management techniques. Current forest management is focused on restoring conifer forest in areas that have become hardwood dominant and transitioning forest stands to uneven-aged. The forestland in the project area and surrounding areas is zoned as timber production zone and other rural land uses.

Site classes

The project area is located within the Northern California Coast, Coast Redwood/Douglas-fir Mixed Conifer assessment area and includes both low and high site forest land. The entire project area, 20,300 acres lies within the Northern California Coast, Coast Redwood/Douglas-fir Mixed Conifer assessment area. Appendix F of the Forest Offset Protocol classifies high site class as Forest Service Types I-III and low site class to IV-VII. An assessment of high and low site class on the project area was completed as described in section 5.3.1 of this document. Common Practice was determined by using a weighted average of acres in each site class and common practice value for each site class.

Table 3 ARB site classes for the northern California Coast, Coast Redwood/Douglas-fir Mixed Conifer assessment area.

Site class	Board feet	Basal area (ft ² per acre)	Common practice (metric tons, CO ₂ /equivalent/acre)
High	27,742	201	188
Low	6,266	176	165

Forest conditions/species composition/age class distribution/management history

Vegetation consists primarily of redwood, Douglas-fir, tanoak, madrone, and herbaceous species including sword fern and redwood sorrel. The project area consists primarily of second and third growth redwood and Douglas-fir forests. These lands have been managed for timber

harvest dating back to the early 1850's by a variety of owners. Historical harvesting included a heavy reliance on clearcutting and burning. As a result, the redwood and Douglas-fir trees on the land were substantially reduced and the tanoak component grew out of balance.

MRC is targeting an uneven-aged stand condition over time. Hardwoods are maintained as approximately 15 square feet per acre across forest stands in the project area. The use of uneven-aged management will ensure that no more than 40% of the Project's forested acreage is in ages less than 20 years at a watershed scale of up to 10,000 acres. MRC analyzes growth and yield at the sustainability unit level. The project area includes 1 sustainability unit that encompasses 20,300 acres which is further divided into planning watersheds primarily less than 10,000 acres in size.

Forest vegetation types

The forest types within the project area are described below:

Redwood-Douglas-fir mixed conifer forest Forests dominated by overstory conifers, a mix of redwood and Douglas-fir

Redwood-Douglas-fir hardwood mixed forest Forests dominated by an overstory mix of redwood, Douglas-fir, and hardwoods

Hardwood dominated stands Forests dominated by hardwood species such as tanoak or madrone.

Land pressures and climate zone

There are limited land pressures in this area for development as most land is utilized for timber production or private ranches. The project is located in Climate Zone 1. This area of California is marked by two seasons – wet and dry seasons. The wet season occurs mostly during the winter months, but often extends into spring (November-April) during this season the area gets the vast majority of its average rainfall. The dry season is marked by long, hot days (May-September) and extremely limited rainfall. The majority of all precipitation on the project area is rainfall with fog also providing water to trees. Snowfall is a very rare event.

3.4 Assessment area within Project Area (Forest Offset Protocol §9.1.1.1(16))

The project area is located entirely within the Northern California Coast, Coast Redwood/Douglas-fir Mixed Conifer assessment area. The total project area is 20,300 acres, which includes 11.3 acres of small non-forest inclusions classified as bare ground, brush fields, or grass.

3.5 Additionality (*Forest Offset Protocol §3.1.2*)

Improved Forest Management Projects automatically satisfy the Performance Standard Test.

3.6 Project Offset Commencement (*Forest Offset Protocol §3.2; §9.1.1(7)*)

For Improved Forest Management Projects – the project commencement date is the date on which an action occurs that increases carbon sequestration or decreases emissions relative to the baseline. According to the protocol, this action must be linked to “a discrete, verifiable action that delineates a change in practice relative to the Forest Project’s baseline.” (page 15). This project commences on the date a “boots on the ground” inventory began for the property-wide carbon inventory – June 4, 2015. This initiation of forest inventory denotes the commencement of this and other carbon projects MRC has listed under the November 2014 Improved Forest Management protocol.

3.7. Sustainable Harvesting Practices (*Forest Offset Protocol §3.8.1; §9.1.1.1(13)*)

MRC meets the sustainable harvest practices requirement by maintaining Forest Stewardship Council certification (RA-COC/FM-000128).

3.8 Natural Forest Management (*Forest offset Protocol § 3.8.2 – Table 3.2; §9.1.1.1 (14); §9.2.1 (10)*)

According to Table 3.2 in the Protocol, projects must meet four eligibility criteria: native species, composition of native species, distribution of age classes/sustainable management; and having no more than 40 percent of the forested acres in ages less than 20 years. Also, forest offset projects must meet the requirement to maintain structural elements. The Hollow Tree project meets all required constraints.

i. Native species

The project area is characterized by a mix of redwood, Douglas-fir, tanoak, madrone, and other native hardwoods. Other species occurring in the area include: bishop pine, California bay, red alder, giant chinquapin, and grand fir. There is a very small component of non-native species that were planted by previous owners for pulp production including eucalyptus and Monterey pine. MRC is working to reduce the occurrence of these non-native species within the project area over time; however these species make up far less than 1% of the basal area per acre of species within the project area. Thus the project meets the 95% criterion for carbon in native species.

ii. Composition of native species

As of 01/04/2016; the project area is composed of approximately 20% redwood, 30% Douglas-fir, 43% tanoak, and 7% other hardwoods. Basal area and proportion by species are

shown in Table 4. MRC is working to reduce tanoak density in stands that were once dominated by redwood and Douglas-fir in order to restore an appropriate ecological balance of conifers and hardwoods. No species will exceed 60% average per acre basal area across the project during the project term.

Table 4 Native species percentage within the project area.

Species	Average Basal Area per acre	Percentage
Tanoak	103.8	43.0%
Douglas-fir	70.9	29.4%
Redwood	47.3	19.6%
Madrone	15.6	6.5%
Canyon live oak	1.0	0.4%
Chinkapin	1.0	0.4%
Red alder	0.9	0.4%
Other hardwood	0.3	0.1%
Knobcone pine	0.2	0.1%
Coast Live oak	0.2	0.1%
Cottonwood	0.1	0.0%
California bay-laurel	0.1	0.0%
Other conifer	0.0	0.0%

iii. Distribution of age classes

MRC is targeting an uneven-aged stand condition over time. Hardwoods are maintained as approximately 15 square feet of basal area per acre across the project area. The use of uneven-aged management will ensure that no more than 40% of the Project's forested acreage is in ages less than 20 years at a watershed scale of up to 10,000 acres. MRC analyzes growth and yield at the sustainability unit level. The project area covers one sustainability unit – Rockport Hollow Tree. This sustainability unit is further subdivided into planning watersheds. For the purpose of demonstrating no more than 40% of the Project's forested acreage is less than 20 years, MRC will use planning watersheds as the ownership level at which the test will be performed. Table 5 lists the planning watersheds included in the project area.

Since MRC is moving towards utilizing uneven-aged management within the project area and have such heterogeneous stands with clumpy distribution of trees, we utilize site class assessments as a proxy for age class assessment. Due to MRC's unique landscape and

harvest history, MRC's forest stands are not classified by age class, but are rather classified by dominant size class and species. This assessment was completed by developing an "average age" for each size class included in our inventory system. To determine if we meet this criteria we utilized 8" as the cut-off for a 20-year old stand, so stands dominated by trees greater than or equal to 8" dbh were considered to be greater than 20 years old. Acres of stands dominated by trees < 20 years old by sustainability unit and planning watershed are listed in Table 5.

Table 5 Planning watershed and acres less than 20 years old.

Planning Watershed	Total Acres	Acres < 20 years old	% of acres < 20 years old
Middle Hollow Tree Creek	9,862	641	7%
Upper Hollow Tree Creek	6,682	366	5%
Lower Hollow Tree Creek	2,313	177	8%
Low Gap Creek	740	0	0%
Jack of Hearts Creek	702	27	4%

*Note there were 12 in other planning watersheds included in the assessment area. These acres were added to the nearest adjacent planning watershed in the above list.

IV. Structural elements

MRC recruits and retains a minimum of 5 downed logs per acre within each silvicultural unit (MRC Management Plan, 2015). In addition, MRC's Management Plan (2015) prohibits the removal of large woody debris in watercourse protection zones unless it is a road obstruction or is moved for stream restoration work. It is expected that the accumulation of lying dead wood on the project area will be commensurate with recruitment from standing dead trees within the Project Area as a component of our forest management objectives.

One salvage harvest was completed in 2015 to harvest damaged trees from a recent wildland fire (Low Gap Emergency Notice; 1-14EM-004MEN; 71 acres harvested in 2015).

As of 1/4/16, current standing dead carbon stocks on the Project Area are 4.41 MG C per acre. This represents 1.9% of the total above-ground live carbon stocks for the Project Area as of 1/4/16. As a vast majority of the Project Area has not recently undergone salvage harvesting (within the last year), MRC will demonstrate that the greater of one metric ton of carbon storage per acre of 1% of standing live carbon stocks is present in standing dead wood, or that progress towards these targets is ongoing. In areas within the salvage harvest, MRC will maintain or demonstrate progress towards an average of at least 2 metrics tons of carbon per acre in standing dead wood.

3.9 Ongoing management activities (Forest Offset Protocol, Section 5; §9.1.1.1(5))

MRC's ongoing management activities are focused on sustainable harvest of timber (less harvest than growth); restoration of tanoak stands to conifer stands; stream and road restoration work; and reforestation stands that have been intensively harvested. Specifically, the activities that will increase carbon stocks are detailed in MRC's management plan (last revised 2015). These include: increased protections on watercourses; increased protections for unstable areas; increasing density and number of large trees on watercourses; increased habitat retention for northern spotted owls (nesting/roosting habitat); and protection of wildlife and old growth trees while also recruiting a minimum of three trees per acres to become wildlife trees.

4. INVENTORY METHODOLOGY

4.1 GHG Assessment Boundary (Forest Offset Protocol Section 5; §9.1.1.1 (19))

The project boundary includes the following carbon pools occurring within the geographic boundaries of the project:

1. IFM-1, standing live carbon (carbon in all portions of living trees),
2. IFM-3, standing dead carbon (carbon in all portions of dead, standing trees),
3. IFM-7, carbon in in-use forest products,
4. IFM-8, forest product carbon in landfills,
5. IFM-14, biological removals from changes in harvesting on forestland outside the project area (leakage)
6. IFM-17, biological emissions from decomposition of forest products.

4.2 Inventory Design and Sampling Process

MRC conducted a forest inventory on the project area from June 4, 2015 to August 31, 2015. This comprehensive forest carbon inventory was designed to meet the requirements of Appendix A of the Forest Offset Protocol. This inventory was developed to quantify standing live and standing dead carbon stocks within the project area. The forest carbon inventory is based on a sample by public land survey section. Public Land Survey sections within the project area were assigned a random number between 0 and 1. Those numbers above 75 percent (0.75) were selected for sampling. An additional section was selected, which was next in the ordering (0.74) in order to meet the minimum sampling goal of 25% of the forested acres.

Within each section, a grid was laid out with a random starting point offset from the southwest corner of each section. Strips at 5 chain intervals were laid out on north-south lines. Sample plots were centered at 5 chain intervals along the strip. Strips were numbered and assigned even or odd; surveyors sampled every other strip within a section; the starting strip was chosen by assigning a random number (1-2). If 1 was chosen, all the odd strips were completed and vice versa if 2 was chosen. A total of 13 sections and 920 plots were completed in the project area. Our goal was to inventory a sufficient number of plots to achieve +/- 5% sampling error of carbon stocks at the 90% confidence level.

4.2.1 Stratification

Prior to sampling, the forest lands within the project boundary were subdivided into distinct forest vegetation types. Typing was done using digital aerial photography taken in June 2013. The forest lands were subdivided into areas (polygons) of similar size, density, and species composition. Buffer zones along streams classified under the California Forest Practice rules as Class I and II were also identified and mapped. As part of the process, the forest within each polygon was classified into species, size class, and density class categories. The primary objectives of the typing operation were to stratify the land base into areas of similar vegetation characteristics in order to increase the precision of estimated attributes, such as board foot volume and standing carbon, and to create stands for input into the growth and yield modeling process that represent the landscape units under the applicable management regimes and constraints.

4.2.2 Stratification Rules

Stand boundaries are identified through aerial photo interpretation. The stand boundaries are defined by the extent of similar vegetation and by other physical characteristics such as roads and watercourses. Other considerations for stand boundaries include:

- Regulatory limitations for even-aged silviculture
- Sensitive areas, vegetation, and wildlife considerations
- Watercourse boundaries

Each stand is assigned a unique number and certain characteristics of the stand are input into a database. The stand is also input into the company's geographic information system so that all information about the stand can be mapped.

Vegetation Classification

Stands with vegetation consisting of redwoods, Douglas-fir, or tanoak as the dominant tree species are classified into one of approximately 40 vegetation classes, based on the stand's

species composition, dominant diameter, and the canopy closure, or density of the stand. A set of standards has been developed to ensure that vegetation classification is consistent.

Size classification is the first component of vegetation classification to be determined. A diameter size class label is assigned to each of MRC's forested stands. MRC's vegetation is classified into five diameter (DBH) classes. The size classes are as follows:

DBH Class	
1	0- 8 inches
2	8-16 inches
3	16-24 inches
4	24-32 inches
5	>32 inches

Tree diameter is measured at breast height. Figure 2 describes the process for determining size class.

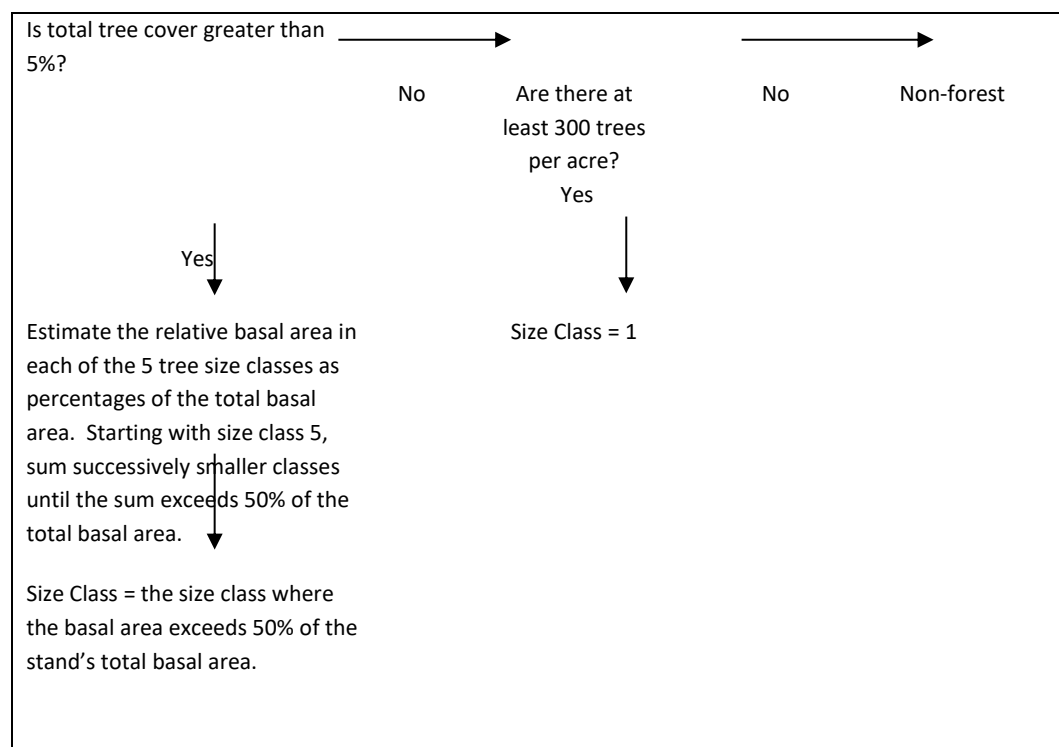


Figure 2 Determining vegetation size classes for stratification in the project area.

Species Classification

Stands that have five percent or more of their area in tree crowns are classified as forest.

Stands that have less than five percent of their area in tree crowns are classified as non-forest.

Non-forest stands are assigned a symbol that describes the predominant cover.

Non-Coniferous Forest Symbols

BR	Brush
GR	Grass and meadows
BG	Bare ground and watercourse beds
WA	Water
PG	Pygmy forest
GX	Oak Woodlands
BP	Bishop pine (Pygmy Type)
RK	Rocky Outcrops

A forested stand is classified with a conifer or hardwood species symbol if 75 percent or more of the basal area in the stand can be attributed to that species. If no one species represents 75 percent or more of the basal area, a mixed-species symbol is used.

Dominant-Conifer Species Symbols

At least 75 percent of the basal area is in the dominant conifer species listed below.

RW	Coast redwood
DF	Douglas-fir
KP	Knob cone pine
WH	Western hemlock
GF	Grand fir

Dominant-Hardwood Species Symbols

At least 75 percent of the basal area is in the dominant hardwood species listed below.

AL	Alder
TO	Tanoak
LO	Live oak
BO	Black oak
MO	Madrone

Two-Species Symbols (Conifer)

Individual conifer species make up less than 75 percent of the stand's basal area, but two conifer species combined make up at least 75 percent of the basal area.

RD	Redwood/Douglas-fir
RM	Redwood/Monterey pine
RE	Redwood/Eucalyptus

Mixed-Species Symbols (Hardwoods)

Conifer species make up less than 75 percent of the stand's basal area. The stand is comprised of a mixture of species that make up 75% of the basal area.

CH	Conifer/Hardwood mix
MH	Mixed Hardwood

Density class

Vegetation polygons were additionally classified by stand density in terms of canopy cover, as observed in the aerial imagery as shown in the table below:

Class Label	Canopy cover
O	Open; canopy cover less than 20%
L	Low; canopy cover 20% to 40%
M	Medium; canopy cover 40 to 60%
D	Dense; canopy cover 60 to 80%
E	Extreme; canopy cover greater than 80%

Sub classes

In many cases the aerial imagery revealed variations within the above vegetation type classes; for example, a sparse large size class stand with a significant understory component, or a stand

dominated by smaller size class that includes an additional significant, but not dominant, overstory component. In these cases, the basic vegetation type classes were expanded to include this additional vegetation type information. The understory classes consist of a species component and a size class component. For example, a polygon with a low density overstory dominated by redwood / Douglas-fir of size class 3 that include a distinct understory of size class 2 conifers and hardwoods would be classified as RD3L_CH2.

Including the subclasses, 124 individual vegetation types were determined on the Hollow Tree project area.

4.2.2 Inventory Strata

The initial vegetation typing based on the aerial imagery resulted in identifying 124 vegetation types. Many of these vegetation types include fewer than 50 acres and/or were not in areas that were sampled in the inventory. We consolidated the strata from the 124 vegetation type classes used for the imagery analysis to 18 inventory strata to address these issues. These 18 inventory strata form the basis for summarizing the inventory data, calculating statistics, and performing the baseline modeling. The consolidation was accomplished by linking the vegetation type classes to 18 inventory strata. The procedure was to assign under-represented vegetation types to the most similar available vegetation type with an adequate plot sample. The determination of “most similar” was based on the aerial imagery used for the original vegetation typing and was not influenced by the inventory plot data. The most common action was to assign vegetation classes with an understory component, such as RD2M_CH2 to its parent class, RD2M which has 28 inventory plots.

Table 6 Final inventory strata for the Hollow Tree project area

Inventory Strata	Plot Count	Acres
CH1D	4	134
CH2D	359	5,958
CH2L	3	145
CH2M	21	1,251
MH2D	20	772
RD1O	3	127
RD2D	50	993
RD2L	11	527
RD2M	28	650
RD2O	18	596
RD3D	58	601
RD3L_CH2	105	3,003
RD3L_RD2	19	630

RD3M	21	730
RD3M_CH2	59	1,202
RD3M_RD2	102	1,662
RD3O	15	670
TO2D	24	649

A map of the vegetation strata is provided in a separate pdf document.

4.2.3 Plot location

Sample plot locations were selected using the ArcGIS fishnet methodology subject to the grid parameters described above. Since roads and landings are netted out of the forested acres for the purpose of expanding the plot data, plot centers that were within 66 feet of roads were offset into the body of the stand in which they occur so that the distance to the road was 66 feet. In cases where the GIS-assigned plot centers within 66 feet of abrupt strata boundaries, the plot centers were offset into the body of the stand so that the distance to the boundary was 66 feet. The objective of performing these offsets was to avoid sampling outside of the strata that the plot represents. Plot centers were monumented with metal flag pins and marked with flagging in order for them to be relocatable for purposes of quality control and for verification.

4.3 Cruise design

Sampling standing live and dead trees (IFM-1 and IFM-3)

A nested plot configuration was used to sample standing live and dead trees. Trees and snags 7.5" dbh and larger were sampled on a variable radius plot. Different basal area factors were used for different strata, with the objective of getting an average of 5 to 7 sample trees per plot. Trees smaller than 7.5" dbh and larger than 1.5" dbh were sampled on a 1/100 acre fixed area plot. Trees smaller than 1.5" dbh were not sampled. Data recorded for all sample trees included species, tree tally, dbh, status code, and canopy position. Status codes indicated the condition of a live tree and the decay class for standing dead trees. Decay classes follow the methodology in Harmon, 2008. The canopy position classes used were: predominant, dominant, codominant, intermediate, and suppressed.

Detailed subsample data were collected on a subset of trees based on a random sample. 25% of commercial conifers were selected for detailed measurements and 10% of other trees. Detail measurements include tree height and height to crown base along with information on defect. Two types of defect data were collected; missing wood defect which affects biomass and carbon stocks, and board foot defect which affects merchantability.

Plot navigation

Cruisers were provided with GPX files containing coordinates of pre-selected plot centers and geo-referenced maps showing the forest type boundaries and mapped roads. Plots were offset for any of the following reasons: (1) plots that fell within the limiting distance of roads were offset into the adjacent stand; (2) plots that fell within the limiting distance of mapped timber type boundaries were offset into the body of the timber type at the original plot center in order to avoid biasing the strata-level results with data from adjacent stand; (3) plots that fell within hazardous area were offset at a bearing selected by the crew in order to vacate the hazard; if the hazard could not be vacated within 3 chains, the plot was skipped. If the hazard could not be vacated in three chains, the cruiser described the hazard condition in the plot notes including photographs. The limiting distance for plot offsets was 1 chain.

4.4 Plot monumenting and measurements

Plot centers were monumented with metal flag pins and marked with flagging in order for them to be relocatable for purposes of quality control and verification. Offset rules were followed under plot navigation. The first tree in each plot was the first tree in the plot starting from north and moving in a clockwise direction. Only snags that supported themselves off the ground were inventoried as snags.

Measurements at the plot level

Plot number was recorded as well as date; crew measuring the plot; slope and aspect of the plot (average percent slope and aspect in degrees of the $\frac{1}{4}$ acre surrounding the plot center). Aspect was measured with a compass and sighting mirror set to local current magnetic declination. Percent slope was measured in 1% increments with a clinometer or relascope. Cruisers also noted anything unusual about the plot (i.e., the side of a cliff).

Tree data collection

For all trees greater than or equal to 7.5 inches in DBH (and snags greater than 15' tall); the following information was recorded:

- Tree number
- Species
- Status code
- Canopy position
- DBH

- After all trees were measured, a random number generator was used to select 25% of commercial trees, and 10% of all other trees for the following characteristics:
 - Height
 - Height to crown base
 - Missing wood defect
 - Board foot volume of defect

Sampling began at cardinal north and closest to plot center and continue clockwise around plot center to complete one rotation. Tree data were recorded in the same order on the datasheet or data recorder.

Trees 1.5 – 7.5" dbh were tallied in a 1/100 acre circular plot (11.78' radius) nested at plot center. Tallies were completed by species and dbh class.

Determining "in" trees

All trees 7.5" dbh and larger were measured if they were "in" the variable radius plot. BAFs for prisms were selected to ensure 6-8 trees per plot occurred on average (allowed BAFs were 10, 20, 27.78, and 40. Cruisers were provided with a BAF for each plot based on the vegetation strata, along with the appropriate plot radius factors. Determining if a tree was "in" the limiting distance used the plot radius factor (PRF) for each basal area factor. The plot radius factor was 2.750 for a 10 BAF, 1.944 for a 20 BAF, and 1.588 for a 30 BAF. The slope of the tape from the center of the tree at DBH to plot center was measured and the appropriate slope correction factor was referenced. The formula used for calculating limiting distance (LD) was: $LD = DBH \times PRF \times SCF$.

Diameter at breast height (DBH)

- Measured trees to 1" precision using a diameter tape if possible. If taping was not possible, a Biltmore stick, Relascope, or other suitable methodology was used (indicating the method in the notes for the tree). When measuring irregularly shaped stems with a Biltmore stick or relascope, readings were taken along the major and minor axes and averaged.
- Default point of DBH measurement was 4.5 feet above ground surface on the uphill side
- For leaning trees, measured 4.5' along the stem from ground surface to upper surface.

- Forked trees below breast height were treated as 2 individual stems, each measured at 4.5 feet above ground.
- Fused stems and other conditions where d-taping was not possible represented a measurement challenge. Cruisers could apply a variety of techniques including averaging multiple Biltmore readings, and taking ½ circumference measurements with the d-tape and multiplying by 2. The objective was to obtain the representation of DBH that would have been obtained using a D-tape. On trees with stem irregularities at breast height including voids, bumps, limbs, forks, cruisers tried to tape the diameter at the point on the stem nearest to breast height and project the tape at that point to breast height, adding or subtracting in order to obtain the equivalent DBH measurement. If the stem had voids or other irregularities that would cause D tape measurements to over- or under-estimate tree volume, cruisers used a Biltmore stick, relascope, or other technique to estimate DBH. The objective was to obtain a DBH estimate that, when used in tree volume equations, would yield the most precise estimate of tree volume.

Trees 1.5-7.5" dbh were measured within a 1/100 acre circular plot (11.78' radius), nested at plot center. Recently regenerated sprout clumps were also tallied on the 1/100 acre plot. Downed wood and woodrat nests were sampled on the 1/10 acre circular lot (37.2' radius).

Tree species

Species were recorded using the following species codes:

RW – redwood
 DF – Douglas-fir
 GF – Grand fir
 WF – white fir
 WH – western hemlock
 SP – sugar pine
 SS – Sitka spruce
 IC – incense cedar
 PY – Pacific yew
 BP – bishop pine
 KP – knob cone pine
 MP – Monterrey pine
 GP – grey pine
 NU – California nutmeg
 OC – other conifer (indicate species in notes)

TO – tanoak
MA – madrone
CB – California bay laurel
BM – big leaf maple
RA – red alder
OA – Oregon ash
GC – giant (golden) chinquapin
CO – coast live oak (q. agrifolia)
LO – canyon live oak (q. chysolepsis)
BO – California black oak (q. keloggii)
WO – Oregon white oak (q. garryana)
VO – valley oak (q. lobate
BL – blue oak (q. douglasii)
EU – eucalyptus spp
WI – willow spp.
WM – wax myrtle (*Myrica californica*)
PD – Pacific dogwood
SY – California sycamore
BC – black cottonwood
OH – other hardwood (indicate in species notes)

Status code

Status code was determined by the status of the tree (codes below). A single tree may have multiple status codes. For snags, status codes included an indicator of snag decay class.

L – live tree, good vigor and form, no defect

SX - snag where x = decay class¹ as defined below

1 – All limbs and branches are present; the top of the crown is still present; all bark remains; sapwood is intact with minimal decay; heartwood is sound

2 – There are few limbs and no fine branches; the top may be broken; a variable amount of bark remains, sapwood is sloughing with advanced decay; heartwood is sound at base but beginning to decay in the outer part of the upper bole

¹ Snag decay classes taken from “Quantification Guidance for Use with Forest Carbon Projects” Climate Action Reserve, January 21, 2014. Decay Class descriptions are in Table 2.3, page 7.

3 – Only limb stubs exist; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay in upper bole and is beginning at the base

4 – Few or no limb stubs remain; the top is broken; a variable amount of bark remains; sapwood is sloughing; heartwood has advanced decay at the base and is sloughing in the upper bole

5 – No evidence of branches remains; the top is broken; less than 20% of the bark remains; sapwood is gone; heartwood is sloughing throughout

N – tree is leaning more than 15 degrees

D -- Dead top (see under defect procedures for measurement protocol)

P – Problem tree

PM – tree has missing wood defect

PV – tree has board foot volume defect

PMV – tree has both missing wood and additional board foot volume defect

O – Old growth tree following MRC's definition described below under "Old Growth Trees".

W – Wildlife tree

- Old growth trees are wildlife trees by definition. It is not necessary to record status code 'W' for old growth trees
- Potential nest trees for marbled murrelets: (a) conifer species; and (b) diameter must exceed 48" for redwood, 36" for Douglas-fir, 36" for grand fir, 36" for Sitka spruce, 30" for western hemlock, or 30" for other conifers; and (c) have at least one platform capable of retaining an egg
- Trees with known raptor nests
- Tree in which the entrance hole leading to cavity is > 3" diameter and 10' or more above the ground.
- Granary trees (any tree with at least 100 small holes filled with acorns or that are capable of holding acorns – that are either tightly clustered or spread throughout the bark or limbs of the tree)

- Trees > 24" dbh with basal hollows that are > 12" wide and deep and extend vertically above the outside cavity

SP – Sprout clump. The clump is measured as a unit, not the individual trees. This is applied to sprout clumps where the individual dominant stems have not yet differentiated.

B – Bat tree. Tree is >42" dbh and has an opening of at least two square feet and an internal ceiling at least 3 feet off the ground.

Canopy position

Canopy position was assigned based on the position of the crown of tree with one of five canopy position codes. Trees with broken top status code were assigned based on the canopy position that the tree would have had without the broken top. Snags were not assigned a canopy position. The canopy position codes are listed below:

P – Predominant (or Emergent); trees whose crowns are above the general level of the canopy and are significantly older than the surrounding stand. This category includes remnant trees regardless of whether they classify as old growth trees.

D – Dominant; trees with well-developed crowns extending above the general level of the forest canopy and receiving full light from above and partly from the sides.

- Dominance is local. A 30 foot tall tree growing in an opening may be locally dominant whereas a 60 foot tall tree 30 feet away growing in a clump of trees may be locally codominant
- Stems of dominant trees will tend to taper more than stems of codominant or intermediate trees, and crown ratio will generally be greater.

C – Codominant; trees with crowns forming the general level of the forest canopy and receiving full light from above, but comparatively little light from the sides. Codominants usually have medium sized crowns.

I – Intermediate: trees with crowns below the general level of the forest canopy and receiving little light from either above or the sides. Intermediates have minimally developed crowns and are crowded on both sides.

S – Suppressed; trees which have their crowns in the lower layers of the canopy. They receive virtually no direct sunlight and they are generally growing very slowly.

Missing/Broken tops

Tree with missing or broken tops meeting any of the conditions below were measured using a special protocol:

- The missing portion represented 5% or more of the volume of an equivalent unbroken tree
- The break occurred beneath a point described as the midpoint of the top 1/3 of the bole of an equivalent unbroken tree. A common assumption is that the top 1/3 of a tree contains 10% of its volume. Therefore, if half of the top third is missing, approximately 5% of the volume is missing, and the tree should be sampled using the Missing/Broken top procedure:

Leave the height field empty, record status code 'PM' (problem tree with missing wood).

Measure the height at the break point.

Try to find a location where breast height and the break point are both visible and when viewed through the Relascope, the stem at breast height covers much of the area between the '0' and 'b' scales. Count and record the number of RUs at DBH. Count and record the number of RUs at the break.

Record in COD1 as "MT/" + [height to break] + "/" + [RUs at BH] + ":" + [RUs at the break]

Example: a tree is broken at 73'; there are 16 RUs at breast height and 6 RUs at the break. Record in defect codes "MT/73/16:6"

An alternative method is to measure the height to the break and measure or estimate the diameter at the break. This method can be used where a location cannot be found where a Relascope sighting on dbh and diameter at the break can be made. This method can also be used on trees smaller than 7.5" dbh. Record in CODx as "MT/" + [height to break] + "/" + [diameter at break]

Example: a tree is broken at 73' and the estimated diameter at the break is 12". Record as "MT/73/12"

If an adequate estimate of the diameter of the break cannot be made, measure and record the height to the break. Record in CODx as "MT/" + [height to break]

Subsample measurements

Subsamples of trees were selected for more detailed measurements. Subsample trees were randomly selected as follows:

- Commercial conifers (redwood, Douglas-fir, grand fir, western hemlock, sugar pine, Sitka spruce, western red cedar) – commercial species 12” dbh and larger that are not old growth – randomly selected trees with 25% probability
- All other trees, except old growth and predominant – randomly selected trees with 10% probability
- Took detailed measurements on all old growth and predominant trees

Height; live and dead standing trees

For trees without top damage – measured height from ground to tip, recorded in height column. For trees with missing or broken tops, used the procedure listed above. If the tip of the tree was dead, but the top was not broken out, assigned status code ‘P’, measured and recorded the height to the tip in the height column. For trees leaning more than 15 degrees, assigned status code ‘N’. From a point perpendicular to the tree’s lean and distance approximately equal to the height, measured the vertical distance from the tip of the tree to the base of the tree; vertically projected the point representing the top of the tree onto the ground and measure the horizontal distance from the point perpendicular to the tree’s lean and distance and equal to height to solve for stem length. In the case of trees with many crooks and bends, estimated the stem length as closely as practicable.

Height to crown base

Occularly compact the crown, mentally pushing lower limbs upward to account for gaps in the crown. The objective is to determine the point corresponding to the base of a normal, symmetrically shaped crown of the same volume. Measure the height to the visually compacted base.

Defect

Two types of defect deductions were recognized: deductions to cubic foot volume and board foot volume that were due to missing wood such as basal hollows and missing tops; and deductions to board foot volume due to defects affecting merchantability such as crooks, sweep, and stem rot. Most defect was found in the butt log or at the top of the merchantable stem. Missing wood defect was determined for all sections of all trees selected for detailed measurement. Board foot volume was only determined for the merchantable bole to a 6” diameter for commercial species 9” dbh and larger. Assessed missing wood defect first. Board foot volume deductions for missing wood were calculated by the compiler.

Missing wood defect

Measured and recorded the height along the stem to the base and top of the stem containing defect.

- Estimated and recorded the percentage of wood that is missing from that section a real (decimal) number, 1 to 100.
- Recorded in defect codes "MW/" + [height to base of section] + ";" + [height to top of section] + "/" + [percent of wood missing]
- Example – a tree has a 20' long scar that begins at height 45'; it is estimated that a 45 degree section extending to the pith (a 1/8 of a circle pie slice) is missing or rotten. Code = MW/45:65/12.5
- Example – a tree has a basal void that begins at ground level and extends 6 feet up the stem. Within that section, approximately 25% of the wood is missing or rotten. Code = MW/0:6/25
- The tree described above also has what appears to be a place where the top broke and has since reiterated. The reiterated top is only about 25% as large as a normal top for a tree of that size. The point where the reiteration occurs is at 50' height. Code = MW/50:999/25 (999 indicates the top of the tree rather than entering the actual height).

Board foot volume defect (commercial trees only)

Assessment of board foot volume defect was performed by 16 foot log sections. Cruisers visually segmented the tree stem into 16.5 foot sections (allowing 6" for trim), starting at the default 1' stump height. Volume defect was estimated as a percentage deduction applied to each affected log. In most cases the percentage can be estimated as a proportion of the 16' log length that was affected.

Avoided double counting – if a tree had missing wood defect, additional board foot volume defect for the same portion of the log was not added. The compiler deducted the missing wood from the board foot volume. However, if a log with missing wood defect contained additional problems, such as sweep, reduced board foot volume in the remaining portion, and added the board foot defect due to the sweep.

Cull Tree (CT) – the entire tree was cull. It produced no logs meeting merchantability specifications (16 foot length, 6" minimum top diameter). Recorded "CT" in defect codes.

For board foot volume deductions other than Cull Tree, recorded "L" + Log number, starting from the stump + Defect code + Percentage deduction, 1 to 100, with decimals as appropriate.

Example – if a tree has a crook in the 3rd log that reduces usable volume by 67%, record “L3CR67”. Recorded defect in one of the COD columns. Only recorded logs showing defect.

Defect codes

- Non-merchantable top (NT):
 - Where the upper stem of a tree is non-merchantable due to a defect condition, record the log number in which the condition occurs and the estimate volume percentage deduction in that log
 - The compiler will assume that any logs above that point are cull.
 - Example – A tree has large limbs, bumps and swellings and evidence of logging damage affecting the entire stem above the 4th log. Record L5NT100
- Miscellaneous board foot deductions (MD)
 - For other conditions meriting a board foot volume deduction (that has not already been recorded as missing wood defect), estimate and record the percentage volume loss.
 - Example – a tree has a scar in the second log caused by logging damage that results in 25% volume loss, but the rest of the stem is merchantable. Record L2MD25.
 - Example – a tree forks into 2 stems at the bottom of the 3rd log. There is no appreciable missing wood defect, but the smaller fork contains no merchantable logs. The 3rd log of the larger fork contains about half the volume of the 3rd log of a normal tree of the same dbh. Record L#MD50. If the remainder of the tree from the 4th log to the tip is non-merchantable, record L4NT100

Down logs

Down logs that met the requirements below were tallied on a 1/10 acre circular plot (37.2 feet radius). Tallied logs meeting the following requirements:

- Logs are classified as hard (material does not fall off when kicked; the sound when kicked is a thud). With soft logs, material falls off when kicked and the sound is muffled. Only tally hard logs.
- Down logs are tallied by size class:

- Large – at least 12' length with average diameter 32" or larger
- Medium -- at least 12' length with average diameter 24" or larger
- Small – at least 6' length with average diameter 16" or larger
- Tally logs that meet the minimum length and diameter specifications within the plot boundary

Recorded log tally by size class. For example, a plot has 1 small log and 2 large logs – record as 1S0M2L. Figure X shows the down log plot layout and measurement protocol:

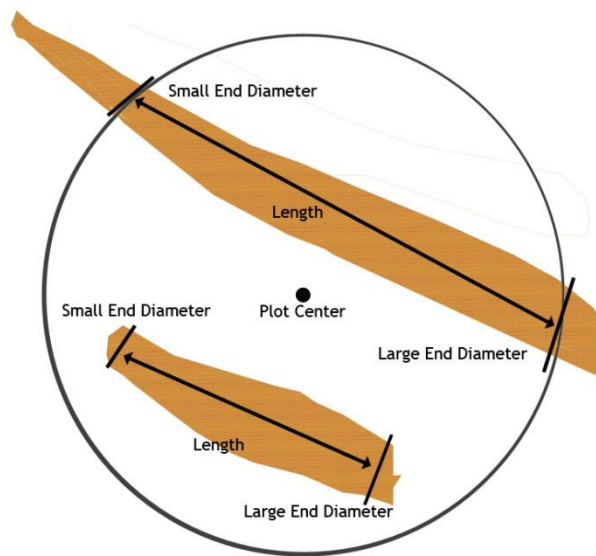


Figure 3 Down log plot layout and measurement protocol for project area carbon sampling.

Old growth trees

Off plot old growth trees that were encountered were included in an old growth tree census. Crews did not travel long distances off the path to collect this information. This census was considered opportunistic, rather than systematic. Refer to the definition of old growth below. Collect the following data:

- GPS latitude and longitude
- Species
- DBH

- Height
- Notes on tree condition including measurement and coding protocol for broken top trees.

Old growth definition

The general definition of old growth is a tree established prior to 1800. Indicators of old growth vary by species as follows

Redwood

- Dbh typically 48" or larger
- Deeply fissured bark
- Flattened or irregular crown; highly complex structure
- Large limbs, in excess of 6" diameter
- Crown debris accumulations
- Platforms
- High presence of complex lichens or moss
- Cat-facing or basal burn cavities (goose pens)

Douglas-fir

- Dbh typically 36" or larger
- Plate-like bark with deep fissures, thick and fire resistant
- High presence of lichens and moss, and where crown soils present; ferns
- Large lateral limbs in excess of 8" diameter
- Flattened, irregular crowns with lower limbs with signs of decay and crown thinning
- Conks
- Partial sagging in tops
- Broken tops

- Crown debris accumulation
- Trees along the margins of vegetation types, which represent pioneer tree individuals, which reoccupied the sites following disturbance. These normally will have limbs extending nearly to the ground and can be wind-shaped

Hardwood

- Dbh typically 36" or larger
- Flattened or irregular crowns, highly complex structure
- Multiple branching crowns with few large well-developed main limbs
- Large limbs in excess of 4" diameter
- Crown debris accumulations
- Platforms
- Cavities, partial snag formation
- Crown die-back
- Cat-facing of basal burn cavities

Equipment list

Inventory personnel used the following equipment for obtaining forest-carbon inventory data:

- Copy of inventory methodology
- GIS maps
- Map atlas of the forestlands
- Waterproof field notebooks
- Spiegel-Relascope with case
- 75' Spencer tape with diameter scale
- Compass
- 16" increment borer

- GPS unit
- Hard hats
- Flagging
- Fire and forestry tools including: shovel, first aid kit, and axe
- 4X4 Pickup trucks
- Tiedowns for ATVs
- ATVs
- ATV helmets
- Leather gloves
- Safety glasses for brushy areas

4.5 Data management system

MRC employs a staff of inventory foresters and forest inventory field technicians to collect field forest inventory data. Use of in-house inventory specialists assures high quality and consistency. In addition, MRC conducts periodic check cruises to verify that data are being collected in a precise and consistent manner.

Data Management Systems and Processes

Field data were entered into field books and then transcribed into a specially formatted Access database under the supervision of the forest inventory manager. The field data were validated and compiled using custom software developed by MRC's forest inventory department. During the validation process, field records are checked to assure that all required data were collected and are within specified ranges, sampling data including the basal area factor are consistent with MRC standards, and status and defect codes comply with the MRC inventory protocol. Data recording errors and inconsistencies were identified by the software and saved in a validation log file to facilitate corrections. During the compilation process individual tree data were converted from field data format to inventory data format, the tree expansion value is calculated, tree height and crown ratio are assigned to trees for which height and height to crown base were not measured, cubic and board foot volumes are calculated, and above ground carbon is calculated for live trees and snags.

The field data and the compiled version of the field data are stored in an Access database. The compiled inventory data are the source of inventory data reports including initial carbon stocks and species composition are the initialization data for the baseline modeling.

Project data are backed up daily and stored with an off-site data archiving service.

4.6 Quantification methodology

4.6.1 Converting inventory data into carbon (IFM-1 and IFM-3)

Data collected in the field are recorded on paper forms and input into Access data tables. The data are imported into a master inventory database and screened for completeness. The data are processed by MRC's plot compiler application which validates the field data, creating an error log if errors are found, and converts the data from field inventory records to compiled treelist data. It calculates the per acre expansion of each tree record based on the plot configuration.

The compiler assigns a tree height to trees whose heights were not sampled in the field inventory by fitting the subsample data to a logarithmic dbh – height function using a nonlinear least squares technique, grouping trees by species and canopy position class. The estimated full tree height is also calculated for trees with broken tops. The compiler also calculates crown ratio for sub sample trees and assigns a crown ratio to non-sub-sample trees.

Above ground carbon in live, normally formed trees without defect is calculated using the equations for California, Oregon, and Washington approved by ARB and published on the ARB website. Carbon in standing dead trees is calculated using the same equations, but with deductions according to snag decay class.

Above ground carbon in live and dead trees with broken/missing tops amounting to more than 5% of estimated volume is calculated by first calculating carbon based on the full unbroken height, then applying a volumetric correction. For conifer trees, the volumetric correction is calculated by first calculating cubic foot volume for full height tree (the unitary volume) using the Wensel & Krumland taper equations. The cubic volume of the stem up to the break point is also calculated using the Wensel & Krumland taper equations. The ratio of broken stem volume to unitary volume is calculated using taper equations is applied to the above ground carbon calculated using the ARB-approved equations. For hardwoods, for which no suitable taper equations are available, the volumetric correction is based on a defect-by-thirds approach, based on the Climate Action Reserve's "Quantification Guidance for Reserve Forest Projects, January, 2014". The underlying assumption is that 10% of a tree's volume is found in the upper 1/3 of the stem, 25% of the volume is found in the middle third and 65% of the volume in the lower third. We use the height to the break recorded in the field to determine the percent of

volume missing, interpolating for heights that fall between the thirds and apply the percentage reduction to the above ground carbon calculated using the ARB-approved equations.

For trees with missing wood occurring in the main stem, field crews measure the height at the base of the affected section, the height to the top of the affected section, and the percentage of wood that is missing from that section. The amount of wood missing is determined by estimating the volume of the defect-containing section using taper equations or defect-by-thirds for conifers or hardwoods, respectively, and applying the percent defect determined in the field to the volume of the section.

Data on board foot volume defect due to sweep, crook, and other factors that affect merchantability (but not biomass) are also collected in the field and used to estimate net board foot volume. Board foot deductions due to merchantability factors are calculated after missing wood deductions have been applied.

Below ground carbon is calculated using equations in Cairns, Brown, Helmer, and Baumgardner, 1997. Root biomass allocation in the world's upland forests. *Oecologia* (1997) 111:1-11. Above ground biomass is estimated for live and dead trees on each plot and combined. The Cairns equation is then applied to the combined standing live and standing dead biomass to estimate the below ground biomass on the plot.

Carbon estimates by pool calculated for each inventory plot are expanded to the landscape via linkage between the inventory plot data and the vegetation map based on vegetation strata codes. Carbon stocking in all combined pools is calculated for each inventory plot. The mean and standard error of mean carbon stocking is calculated for each stratum, based on the inventory plots within the strata. These statistics are then multiplied by strata acres to calculate total stocking and standard error of total stocking for the strata, which are summarized to calculate the project area stocking and its standard error.

IFM-6 Soil: Excluded

Soil carbon is excluded from this project since no site preparation activities exceeding 25% of the project area or mechanical site preparation conducted on contours will occur within the project area during the life of the project.

IFM-7 and IFM-8 Carbon in harvested forest products

MRC tracks each load of logs from each timber harvest plan on the project area. Each log load is associated with a source code which identifies the THP and links it to the project area. At the mill, the board foot volume for each load is determined via a sample scaling process. Volumes for each load, along with each THP and harvest unit are tracked in a database. Annual harvest

volume reports pull data from the database for each log load from each THP and harvest unit within the project area boundaries. Carbon in harvested forest products is calculated from annual harvest volumes following the procedures in Appendix C of the Protocol.

IFM-9 Biological emissions from site preparation activities: Excluded

This pool is excluded since site preparation activities do not exceed 25% of the project area and mechanical site preparation activities are not conducted on contours within the project area over the life of the project.

IFM-14 Biological emissions/removals from changes in harvesting on forestland outside the Project Area

Leakage is estimated using a default 20% leakage factor applied to the difference in harvest volume relative to the baseline. A separate inventory methodology for IFM-14 is not required. The entire inventory process, including stand delineation and vegetation typing will be repeated at intervals not to exceed 12 years. All plots older than 12 years will be retired, and their data eliminated from the standing inventory database.

IFM-17 Biological emissions from decomposition in forest products

This is quantified as a component of IFM-7 and IFM-8 per Appendix C of the Protocol.

4.7 Inventory updates

At the beginning of each calendar year, MRC updates the forest inventory to account for harvest, disturbance, growth, and any other factors that may affect carbon stocks or board foot volumes.

Harvest areas are mapped in our GIS system during the preparation of timber harvest plans. Stands that were harvested during the previous year are assigned strata labels corresponding to the post-harvest condition, according to the silviculture employed. For example, a stand whose pre-harvest strata label was RD3M that undergoes selection harvest is reassigned to strata RD3L; the difference in carbon stocking between the RD3M strata and the RD3L strata times the acres in the stand is captured as a “depletion”. Note that this strata re-assignment methodology only applies until the next aerial imagery becomes available; at which time the affected area will be stratified according to the photointerpretation rules. Other disturbances, such as wildfire, are handled in a similar manner. After accounting for harvest and disturbance, the inventory plots are grown forward 1 year and the project area carbon stocks are recalculated based on the updated inventory plots.

4.8 Known or Potential Diseases

Sudden Oak Death, *Phytophthora ramorum*, is known to occur in western Mendocino County. It is a fungal disease that attacks tanoak and California bay laurel, which are 2 of the more prevalent hardwoods in the project area. SOD can cause widespread mortality in affected tree species; however, no significant outbreaks have occurred in, or in the vicinity of, the project area.

5. Baseline Carbon Stocks

Please note the baseline carbon stock assessment is a model of the maximum sustainable harvest available under the Forest Practice Rules that is financially feasible and results in carbon stocking equal to or greater than the Common Practice value. MRC will continue managing the forest as proposed in our Forest Management Plan and Option A; this assessment is merely a modeling exercise.

5.1 Legal Constraints (Forest Offset Protocol §6.2.1.2; Appendix B.3; §9.1.1.3(4))

Harvest in the baseline analysis is constrained by several factors. Primarily, the California Forest Practices Rules (FPR, 2015) create a minimum set of resource protection standards including silvicultural minimum standards that provide minimum basal area triggers and retentions for the various silvicultural prescriptions. Legal requirements include all laws, regulations, and legally-binding commitments applicable to the Project Area at the time of the project's initiation that could affect standing live carbon stocks. The project area is subject to the Z'berg-Nejedly Forest Practice Act of 1973 (FPA) and the corresponding Forest Practice Rules (FPR). The rules that specifically effect the determination of baseline are those that include limits to silviculture activities. This includes the requirements for minimum basal area retention, stocking requirements, rotation ages, harvest adjacency restrictions, watercourse buffer zones, and habitat protection zones associated with activity centers of the northern spotted owl.

5.2 Consideration of Financial Constraints (Protocol § 6.2.1.3; § 9.1.1.3 (5))

The MRC Hollow Tree project modeling shows that the growth and harvesting regime used for the baseline is financially feasible with the following financial analysis of anticipated growth and harvesting regime that captures key costs and returns while taking into account legal and biological constraints.

5.2.1 Baseline financial assessment

Stumpage values were set based on the species harvested and harvest type (tractor or cable) and then blended to determine an appropriate stumpage value for all prices. Stumpage values

were as follows (following the California Board of Equalization harvest values schedule June 1st, 2015 – December 31, 2015):

Redwood, tractor harvest = \$630/mbf

Redwood, cable harvest = \$590/mbf

Douglas-fir, tractor harvest = \$260/mbf

Douglas-fir, cable harvest = \$210/mbf

Blended rate = \$460/mbf

Blended rate assumes 50% tractor harvest, 50% cable harvest; and a species mix of 60% redwood and 40% Douglas-fir. This blend best represents historical overall rates of harvest at MRC by type and species.

Fixed costs were estimated in two components: (1) management costs and (2) taxes. Both were estimated based on acres in the project and therefore are fixed over time. Management costs were estimated at \$2,029,900 per year while taxes were estimated at \$81,196 per year – resulting in a total cost of \$2,111,096 per year. Management costs include the costs of writing harvest plans, maintaining and upgrading roads associated with timber harvest plans, spotted owl and other threatened or endangered species survey work, and security.

A discount factor was set at 6%. Volume estimates were generated by modeling the baseline scenario.

Table 7 Financial input variables for financial feasibility analysis of baseline model for project area.

Variable	Unit	Value
Discount factor timberland	%	6%
Stumpage redwood, tractor harvest	\$/mbf	\$630
Stumpage redwood, cable harvest	\$/mbf	\$590
Stumpage Douglas-fir, tractor harvest	\$/mbf	\$260
Stumpage Douglas-fir, cable harvest	\$/mbf	\$210
Fixed costs, management	\$/yr	\$2,029,900
Fixed costs, taxes	\$/yr	\$81,196

During the initial 16 years of the baseline, costs and revenues are closely matched. From year 17 forward, revenues exceed costs as the harvest volume increases in response to growth.

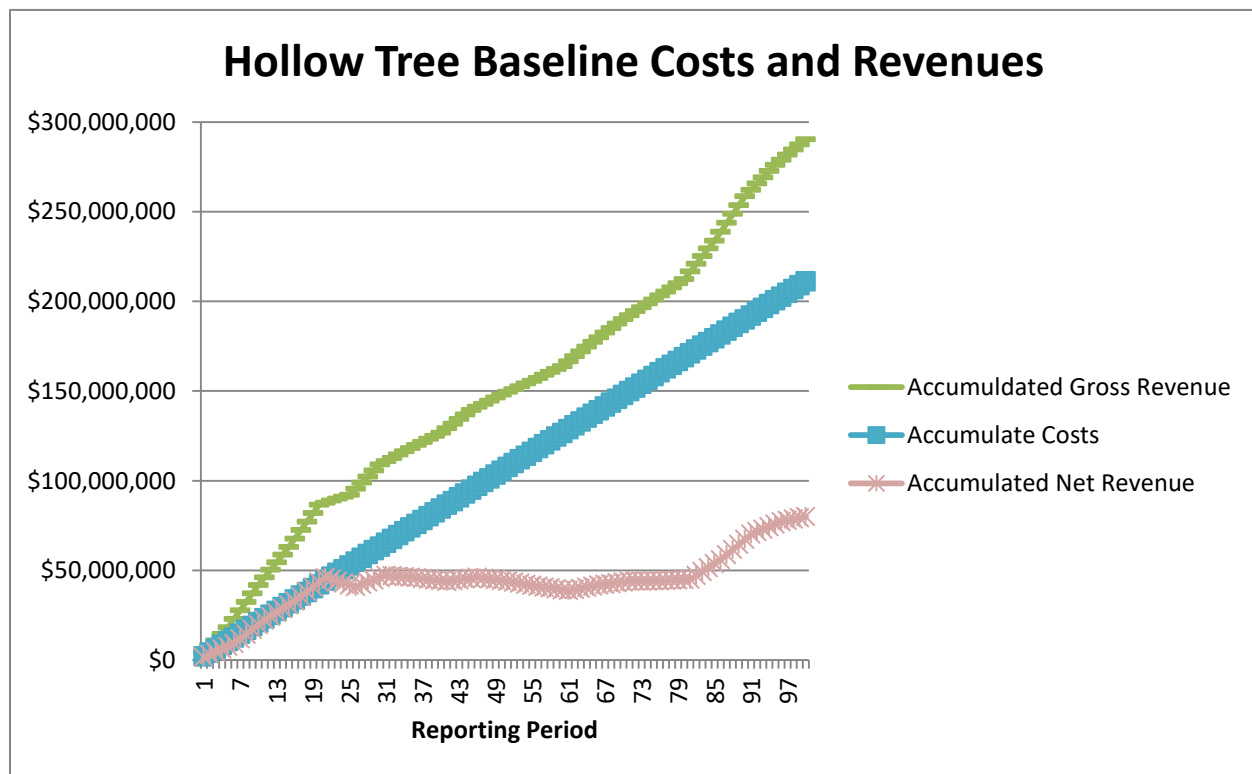


Figure 4 Accumulated gross revenues, net revenues, and costs for the project area under the baseline scenario.

5.2.2 Conclusion – baseline financial feasibility

Results from baseline modeling indicated that the baseline scenario is financially feasible at a NPV of \$\$23,794,716 over 100 years or \$\$1,172/acre. Thus, the baseline model is financially feasible and meets the requirements of the Protocol.

5.3 Estimating baseline onsite carbon stocks (Private Lands) (Forest Offset Protocol, § 6.2; § 9.1.1.1 (21); § 9.2.1 (13))

Following the outline in Section 6.2 of the Protocol, the baseline approach for Improved Forest Management project on private lands has four steps:

1. Determine the Common Practice level of above-ground standing live carbon stocks applicable to the Project Area.
2. Determine if the Project Area’s initial above ground standing live carbon stocks are greater than or less than Common Practice.
3. Estimate baseline above-ground standing live carbon stocks, taking into account financial and legal constraints on harvesting within the Project Area.

4. Determine the baseline carbon stocks over 100 years for all required and optional carbon pools.

5.3.1 Step 1 – determine the Common Practice value of above-ground standing live carbon stocks in the project area

The project falls entirely within the Northern California Coast – Coast Redwood/Douglas-fir Mixed Conifer assessment area and includes both high and low site acreage.

The common practice value (CPV) for the Hollow Tree Carbon Project (Hollow Tree) was determined using soil type / site productivity data within the Hollow Tree project boundaries obtained from the Natural Resources Conservation Service’s Web Soil Survey. The Web Soil Survey data includes the number of acres by soil type within the project area along with the percentage of minor soil types, referred to as components. The site productivity expressed as Mean Annual Increment (MAI), cubic feet / acre / year, is listed by component, which are soil series within the type. For components that include both redwood and Douglas-fir sites we used MAI values for redwood. Components where redwood is not found list only the MAI for Douglas-fir. MAI values were assigned to site class groups “High” and “Low” according to Appendix F of the COP. The number of acres within each site class group was summarized, and the acre-weighted average above ground carbon stocks (CO₂ equivalent) was determined based on the values in column G of the assessment area data file. The Common Practice statistic was calculated by taking the Common Practice Statistic for low and high site areas and weighting it by acreage in each site class, resulting in an average Common Practice Statistic of 184.6.

Table 8 Common Practice Statistic Calculation for the Hollow Tree project.

	Low site	High Site	Sum
Acres	2982	17317	20300
			Weighted Average
Common Practice	165	188	184.6

5.3.2 Step 2 – determine if the Project Area’s initial above ground standing live carbon stocks are greater than or less than Common Practice (Forest Offset Protocol § 9.1.1.3 (2)).

Initial above-ground standing live carbon stocks

The Project Area's initial above-ground standing live carbon stock was calculated using data collected from our field inventory. First, as discussed in Section 4, we stratified the Project Area into 18 inventory strata. Then the carbon in above-ground standing live tree per plot was estimated using the quantification methods described in Section 4. Since the date of commencement of the project is the date of initiation of forest inventory, above-ground standing live carbon stock was expanded to the landscape via linkage between the inventory plot data and the vegetation map based on vegetation strata codes. Carbon stocking in each pool is calculated for each inventory plot. The mean and standard error of mean carbon stocking is calculated for each stratum, based on the inventory plots within the strata. These statistics are then multiplied by strata acres to calculate total stocking and standard error of total stocking for the strata, which are summarized to calculate the project area stocking and its standard error. See the inventory strata summary statistics table in section 6.1.1 below.

The average above-ground standing live carbon stock for the Project Area was estimated by taking the weighted average above-ground standing live carbon stock across strata (Table 10). The initial above-ground standing live carbon stock was 219.9 MTCO₂e/acre, which is above the Common Practice estimate of 184.6 MTCO₂e/acre (Table 9).

Table 9 Weighted average above-ground live MTCO₂e for the Project Area.

Vegetation Type	Gross Acres	Net Acres	Average Above-ground live C Stocks, mtCO ₂ e
CH1D	134.25	131.35	219.78
CH2D	5,958.28	5,829.58	235.81
CH2L	144.77	141.64	54.37
CH2M	1,251.27	1,224.24	181.34
MH2D	772.05	755.37	263.39
RD1O	126.62	123.89	28.56
RD2D	991.92	970.50	258.16
RD2L	526.61	515.24	95.53
RD2M	649.51	635.48	199.64
RD2O	596.38	583.50	94.71
RD3D	600.57	587.60	289.90
RD3L_CH2	3,003.27	2,938.40	217.40
RD3L_RD2	629.52	615.92	190.84
RD3M	731.70	715.89	211.18
RD3M_CH2	1,201.58	1,175.62	241.59
RD3M_RD2	1,661.59	1,625.70	266.61

RD3O	669.75	655.28	139.59
TO2D	649.33	635.30	289.72

Total project acres 20,300
Weighted Avg AGLC 219.7

5.3.3 Step 3 and Step 5 – Determine baseline above-ground standing live carbon stocks and all onsite carbon pools.

MRC assessed the baseline above-ground standing live carbon stocks by modeling above-ground carbon standing live carbon stocks with a growth and harvest scenario designed to mimic the harvest scenario that most closely approximates legal harvesting constraints on the forestlands. We then estimated baseline carbon stocks for all required carbon pools.

Growth and yield model description

MRC’s forest growth and yield modeling system consists of several components:

- 1) A land base component which includes the GIS shapefiles depicting the vegetation strata and soil types, watercourse and lake buffers prescribed by CalFire, buffers surrounding activity centers of the northern spotted owl, and harvest units associated with active THPs;
- 2) A forest inventory database;
- 3) The DLL configuration of the CRYPTOS growth model;
- 4) A forest growth and management modeling application, Gamma 5, which performs silviculture simulations, manages the growth projection process, and calculates carbon stocking and other outputs;
- 5) A planning module, which is used to link project acres to the growth and management simulation results.

Baseline modeling

Overview

The baseline scenario for the Hollow Tree project is conventional even aged forestry in which stands are harvested by the clear cut method and regenerated by sprouting and/or planting of redwood and Douglas-fir. Habitat protection measures specified in the California

Forest Practice Rules are followed as prescribed in the rules. The ability to conform to adjacency requirements and avoid negative cumulative impacts is modeled by phasing in the initial harvest entry over a 20 year period for most strata. A few strata with relatively low stocking could not be harvested during the first 20 years while producing the minimum harvest yield. These strata were grown forward and the treatment entries were phased in beginning after 20 years. One timber harvest plan that was active and not yet harvested at project commencement is modeled separately.

Modeling Units

The basic modeling units for the baseline were created by intersecting the forest inventory strata with the NRCS soil type layer with WLPZ zones and NSO management zones associated with NSO activity areas.

The NRCS soil maps define site productivity in terms of cubic feet MAI. Some soil types include MAI values for both redwood and Douglas-fir, while others provide MAI only for Douglas-fir. We converted the MAI values to 50-year site index values and grouped these into site classes based on the site index groupings in Krumland and Eng, 2005.

Areas that are not within a WLPZ or NSO buffer are assigned management code “Unconstrained”. Areas that fall within a buffer zone are assigned a management code indicating the type of buffer; e.g., a WLPZ Class I inner buffer zone will be assigned management code “W1_Inner”.

The FPR prescribes a number of WLPZ buffer widths, some of which vary by side slope class. The buffer widths themselves are specified in terms of slope distance. Since a digital terrain model of suitable precision was not available to perform a side slope analysis for the baseline modeling, we based the WLPZ and NSO zone widths on horizontal distance, resulting in a somewhat larger total area in protected buffers than a strict adherence to the FPR would require. For the baseline scenario, this is a conservative assumption.

The inventory strata provide the treelist to be modeled; the site class determines the site index used by CRYPTOS to grow the trees, and the management code controls the available prescriptions.

The NRCS Web Survey soil data includes values for cubic foot MAI for redwood and Douglas-fir for forested soil types. We used equations developed by Hanson, Azuma, and Hiserote (2002) to convert the MAI values to 50 year site index values and then classified them as to

site class based on Table 9.2 Krumland and Eng (2005). Where the web soil survey data included MAI values for both redwood and Douglas-fir, we used both; creating site class groupings. For example, soil type 153 includes MAI site class values for both redwood and Douglas-fir, both of which correspond to site class III. The site class group for soil type 153 is therefore “III/III”. These site class values are passed to the CRYPTOS model. Site index for the other species are based on comparison to redwood or Douglas-fir site class, based on default values used in FORSEE.

A modeling unit therefore consists of inventory strata in addition to site class and management code, for example “RD2D_III/IV_1LCore”.

Table 10 Management Codes used for baseline modeling.

Management Code	Description
NoHarv	Includes WLPZ core zones, NSO core zones, and inner gorges where harvest is not allowed.
1-Inner	The inner zone of class I watercourses. Limited harvest allowed.
1-Outer	The outer zone of class I watercourses. Harvest allowed; 50% residual canopy cover required.
1-SOZ	A special operations zone on north facing slopes adjacent to class 1 watercourses. Harvest allowed subject to canopy cover retention requirements
2L-Inner	The inner zone of large class II watercourses. Limited harvest allowed.
2S-inner	The inner zone of small class II watercourses. Harvest allowed subject to canopy cover retention requirements.
3-ELZ	The equipment limitation zone appurtenant to class III watercourses. Harvest allowed subject to understory retention requirement.
Steep	Areas identified as steep or unstable slopes in MRC’s geology database. Harvest subject to 50% canopy cover retention.
NSO-HomeRange	The area extending from 500 feet to 0.7 miles from an NSO activity center. Subject to habitat retention restrictions.
Unconstrained	Areas with no special harvest restriction; subject to the general constraints in the forest practice rules. The EvenAge prescription is applied to these lands under the baseline scenario

Harvest strategy

Each modeling unit is associated with a management code that determines the silvicultural prescriptions applied to the unit. Modeling units with constrained management codes are assigned prescriptions that comply with forest practice rules requirements for those zones. In the unconstrained areas the harvest strategy under our industrial forestry baseline scenario is to apply the clear cut method when conifer stocking is sufficient and apply the rehabilitation of understocked stands method where conifer stocking is inadequate. The interval between entries and size of entries for even age management is restricted under the forest practice rules, based on the site class. The industrial scenario would move the forest to a complex of even aged stands, along with the buffer zones and habitat protection areas prescribed in the rules, which are either unharvested or under some form of selection management. We spread the conversion over a period of 20 years in order to reduce the potential impacts of cumulative effects.

Silviculture methods

Nine different silviculture prescriptions are available in the baseline scenario for lands not included in active THPs. Table 12 shows the prescriptions assigned by management code.

Table 11 Baseline prescriptions assigned to management codes.

Management Code	Silviculture Prescription
NoHarv	LetGrow
1-Inner	FPR_W1_Inner
1-Outer	FPR_W1_Outer
1-SOZ	SEL_CAN_50
2L-Inner	FPR_W1_Inner
2S-Inner	SEL_FPR_2S
3-ELZ	SEL_FPR_3ELZ
Steep	SEL_CAN_50
NSO-HomeRange	A compound prescription in which 3 prescriptions are applied to different proportions of the home range: 14% to NSO-NestRoost, a selection method where the post harvest stand meets the requirements for Nesting/Roosting habitat 33% to NSO-For, a selection method where the post harvest stand meets the requirements for Foraging habitat 53% to EvenAge
Unconstrained	EvenAge

Table 12 Description of baseline prescriptions used in baseline modeling.

Prescription ID	Description
EvenAge	General forest prescription for baseline scenario. If the unit's age, based on site index age of the 30 tallest conifers, is equal to or greater than the age for regeneration harvest under the rules (a function of site class), the unit is clearcut and restocked, with a hardwood control follow up treatment 5 years later. Commercial thinning occurs when the unit can generate a commercial harvest while observing the stocking retention requirements in the FPR. If the unit does not meet the requirement for a regeneration harvest and is under stocked in conifers and overstocked in hardwoods, it undergoes a rehabilitation treatment, followed by commercial thinning when it meets the requirements described above. Units are clear cut when the site index age of the tallest 30 conifers meets the requirements of the FPR.
FPR_W1_Inner	Implements the cutting strategy described in 14 CCR 916.9 (f)(2)(B): - retain the 13 largest conifers per acre - thin from below - post harvest conifer minimum canopy cover is 25% - post harvest minimum canopy cover, all trees, is 80% - sprouting species will sprout on cut stumps - natural regeneration by seeding will occur but will be limited due to high residual canopy cover If both canopy cover constraints cannot be met, no harvest will occur.
FPR_W1_Outer	Implements the cutting strategy described in 14 CCR 916.9 (f)(2)(C): - single tree selection - post harvest overstory canopy cover 50% or more - post harvest conifer overstory canopy cover 25% or more - sprouting species will sprout on cut stumps - non sprouting species will seed in at a rate determined by canopy cover
SEL_CAN_50	Single tree selection with post harvest canopy cover 50%. - retention priority is conifers of good vigor and form - old growth and wildlife trees are not cut - sprouting species will sprout on cut stumps - natural regeneration by seed occurs in relation to canopy cover

Prescription ID	Description
SEL_FPR_2S	A custom implementation of selection harvest under the specifications of the forest practice rules for which: - at least 50% of the pre-harvest canopy cover is retained - at least 25% of pre-harvest conifer overstory canopy cover is retained - post harvest basal area stocking complies with section 913.2 (a) of the forest practice rules -complies with seed tree and residual tree phenotype requirements of section 913.1 (c) of the forest practice rules - sprouting species will sprout on cut stumps - natural regeneration by seed occurs in relation to canopy cover
SEL_FPR_3ELZ	A special implementation of selection harvest under the specifications of the forest practice rules for which: - at least 25% of pre-harvest understory canopy cover is retained - post harvest basal area stocking complies with section 913.2 (a) of the forest practice rules -complies with seed tree and residual tree phenotype requirements of section 913.1 (c) of the forest practice rules - sprouting species will sprout on cut stumps - natural regeneration by seed occurs in relation to canopy cover
NSO_NestRoost	A special implementation of selection harvest for which the post harvest stand meets the minimum requirements for NSO Nesting/Roosting habitat as defined by USFW Attachment A: - retain at least 60% canopy cover in trees 11" Dbh and larger - retain at least 100 square feet basal area in trees 11" Dbh and larger - remove no more than 1/3 of stand basal area - sprouting species will sprout on cut stumps - natural regeneration by seed occurs in relation to canopy cover
NSO_For	A special implementation of selection harvest for which the post harvest stand meets the minimum requirements for NSO Foraging habitat as defined by USFW Attachment A: - retain at least 40% canopy cover in trees 11" Dbh and larger - retain at least 75 square feet basal area in trees 11" Dbh and larger - sprouting species will sprout on cut stumps - natural regeneration by seed occurs in relation to canopy cover
LetGrow	The no treatment alternative, which is available for all vegetation units. Natural regeneration occurs as a function of species composition and canopy cover.

Timber Harvest Plans

There were 3 active timber harvest plans in the project area at the time of project commencement plus one emergency notice for a sanitation-salvage harvest following the 2014 Lodge Lightening Complex fire. Operations on 2 of the THPs and the emergency notice had commenced prior to project commencement and were completed during the initial reporting period, prior to collection of inventory data

The North Islam John THP (THP # 1-15-084-MEN) was active and unharvested at the time of project commencement. Table 14 shows the associated silviculture regimes and acres modeled in the baseline.

Table 13 Silviculture treatments modeled in the baseline scenario.

Silvicultural Treatment	Acres	Description
Group Selection	99	Remove trees individually or in small groups. Upon completion of operations stands will have at least 75 square feet per acre basal area which will include 40 sq ft greater than 16" dbh and 35 sq ft less than or equal to 16" Dbh.
Rehabilitation	34	Reduce hardwood stocking to 15 sq ft / ac; Retain 5 sq ft / ac of conifers > 16" Dbh; plant as necessary to bring the stand up to stocking standards
Transition	94	Reduce hardwood stocking to 15 sq ft / ac; retain 50 sq ft conifer basal area; retain at least 10 sq ft conifer basal area > 16" Dbh
Variable Retention	183	Retain large trees (> 16" Dbh) at 10 – 27.5 sq ft / ac averaged across the stand, with retention level based on stand size; selecting the best phenotypes, except for retention of trees for wildlife and structural purposes. Retain hardwoods at 15 sq ft / ac . Plant as necessary to bring stand up to stocking standards.

Regeneration assumptions

The growth modeling system simulates regeneration during a projection run using different strategies, depending on the prescription. For the LetGrow prescription, a Natural regeneration routine simulates establishment of conifer seedlings based on the species composition of the vegetation strata being modeled. The actual number of seedlings planted on each plot depends on the canopy cover of the plot.

For prescriptions that include harvest, an underlying assumption is that redwoods and hardwoods will sprout, with the number of sprouts being a function of the diameter of the parent tree and the cutting intensity. If the predicted post-harvest sprouting would not meet the stocking standards in the FPR (14 CCR 912.7), additional seedlings are planted so that the stocking standards are met, as required by the rules. The stocking standards and supplemental planting are implemented at the plot level.

Growth model

The CRYPTOS model is used to simulate growth of the forest. MRC's landscape model uses the DLL configuration of CRYPTOS which is the same growth engine used by FORSEE. During each 5-year growing cycle in a projection, any scheduled silviculture is executed first, then the resulting stand is grown forward. Gamma 5 grows each individual plot separately, the method recommended by Dr. Lee Wensel, co-developer of the CRYPTOS model. After growth is completed, attributes such as above ground live carbon is calculated based on the updated tree dbh and heights. Regeneration is added at the end of the growth cycle.

Calibration

Much of the data used to build the CRYPTOS model was collected on lands now owned by MRC, including the project area, and on the nearby Jackson State Demonstration Forest and surrounding commercial forestland. The mix of species and stand conditions that are encapsulated in CRYPTOS is therefore a very close match to the mix of species and conditions occurring on the project area, and is the most suitable model available. Additional calibration was not performed.

5.3.4 Description and estimate of the Forest Project's baseline onsite carbon stocks

Figure 5 illustrates the carbon stocks in the baseline over time from the baseline carbon model run. The initial reduction in carbon stocks over the first 16 periods is the result of conversion of mixed age stands to even aged stands using the clear cut method plus the reduction in hardwood stocks in stands cut using the Rehabilitation method. The increase in stocks following the initial decline is due to the fact that faster growing conifers have replaced the slower growing hardwoods.

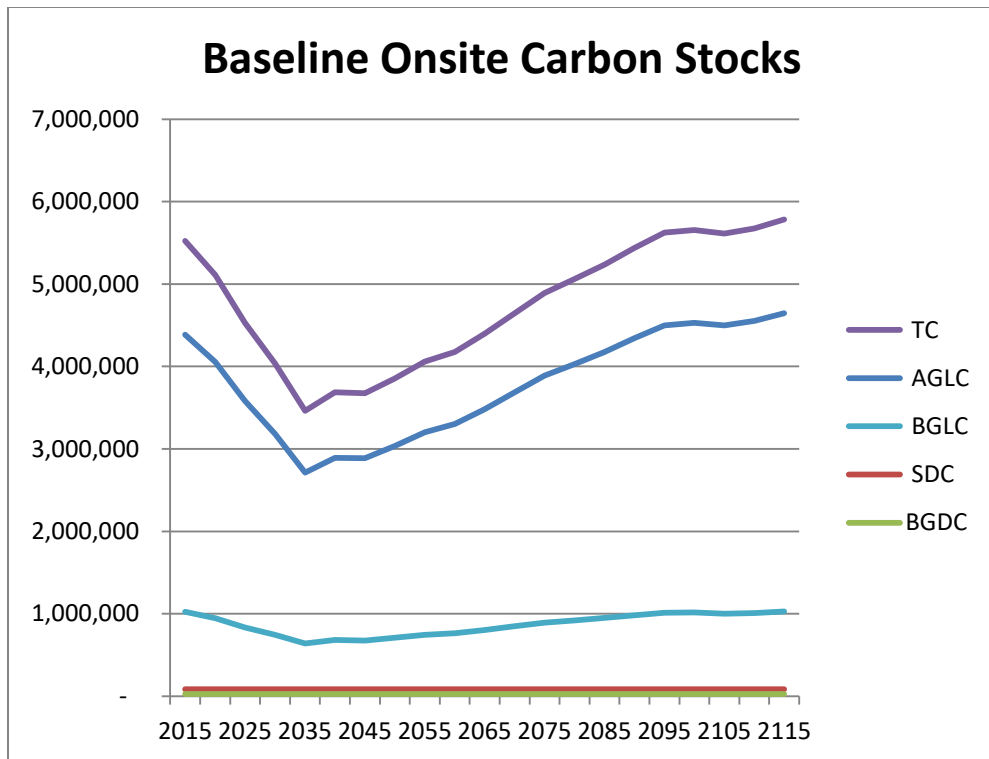


Figure 5 Baseline carbon stocks for all required carbon pools on the project area.

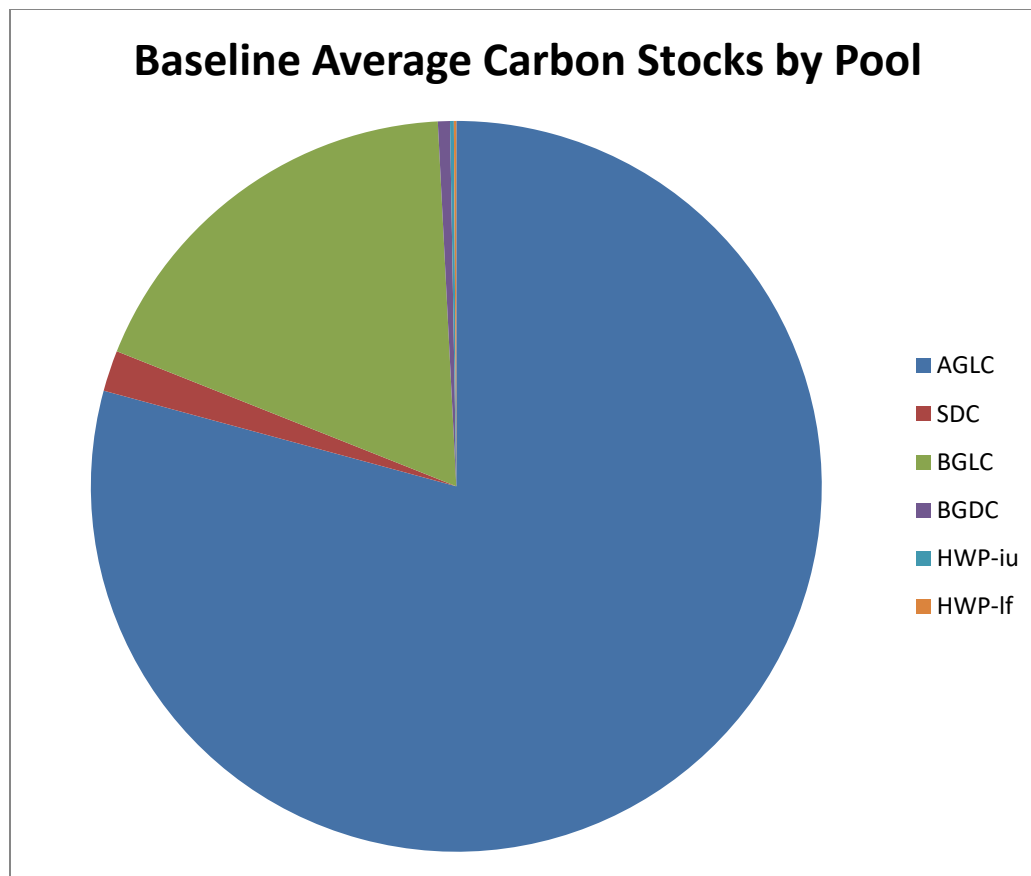


Figure 6 Baseline Average Carbon Stocks by Pool. Captions: AGLC = Above-ground live; SDC = Standing dead; BGLC = Below-ground live; BGDC = Below-ground dead; HWP-iu = Harvested Wood Products in use; HWP-lf = Harvested Wood Products in landfills.

Figure 6 is a diagram of the final baseline incorporating all required carbon stocks. Values for above-ground live, standing dead, and below-ground carbon represent the average stocking over the baseline. Values for harvested wood products are the total of annual contributions over the baseline. The annual estimates of carbon stored in harvested wood products over the baseline for in-use and landfills are 7,845 and 5,065 metric tonnes CO₂e, respectively.

Table 14 Baseline results show 100 year average of above ground carbon stocks equal the Minimum Baseline Level.

Baseline results	MTCO ₂ e/acre
Initial above-ground live standing stocking	216.2
Common Practice	184.6
Minimum Baseline Level (MBL)	184.6

100 year above-ground standing live stocking	185.0
--	-------

5.4 Updating inventory and carbon stocks (Forest Offset Protocol § Appendix B.3; Forest Offset Protocol §9.1.1.1 (21)).

Please refer to the discussion under section 5.3.3 above.

5.5 Determination of Minimum Baseline Level (Forest Offset Protocol § 6.2.1)

The initial above-ground live carbon stocks are above Common Practice. Hence, we use Equation 6.5 in the Forest Offset Protocol to calculate Minimum Baseline Level.

Equation 6.5:

$$MBL = CP$$

Where,

MBL = minimum baseline level (above-ground standing live carbon stocks)

CP = Common Practice (as determined in Section 5.3.1 above).

$$MBL = CP$$

$$CP = 184.6 \text{ MgCO}_2\text{E/acre}$$

5.6 Estimating baseline carbon in harvested wood products (Forest Offset Protocol § 6.2.3)

Carbon in harvested wood products is calculated within the baseline model based on the cubic volume of logs and the wood density values prescribed in the ARB biomass equation reference updated September 9, 2014. The annual average carbon in harvested wood delivered to mills is 6,974 tonnes. This value is input in Step 2 of the procedures in FOP Appendix C. The mill efficiency value specified in the regional mill efficiency workbook for the northern California coast, 0.675, was used. Following the procedures in FOP Appendix C, we calculated the values below in Table 16

Table 15 Average carbon stored in wood products and landfill over 100 years (Forest Offset Protocol §9.1.1.1 (26)).

IFM – 7 Baseline carbon stored long-term in-use wood products (tonnes CO ₂ e)	7,924
IFM – 8 baseline carbon stored in landfills (tonnes CO ₂ e)	

	5,116
--	-------

Note – IFM-17 (biological emissions from decomposition in forest products) is included in the calculations of IFM-7 and IFM-8.

5.7 Quantifying secondary effects (Forest Offset Protocol § 9.2.1 (14)).

IFM-14 includes secondary effects emissions from shifting activities in the project baseline with a 20% factor applied to baseline harvested wood products (Table 17). The secondary effect is also accounted for in the calculation worksheet.

Carbon in trees harvested for wood products (commercial conifers only) was calculated in the baseline run and converted to an annual value of 42,685 tonnes CO₂e. Actual carbon in trees harvested for wood products was 15,680 tonnes. The estimate of secondary effects is 5,401 metric tonnes CO₂ equivalent, calculated as 20% of the difference between the baseline and actual carbon in trees harvested for wood products.

6. Project Carbon Stocks

6.1 Actual onsite carbon stocks

Hollow Tree's onsite carbon stocks are updated each year of the crediting period in order to account for changes due to tree growth, harvest, and disturbance. The change in carbon stocks due to tree growth is estimated using the CRYPTOS growth model applied to the inventory data at the beginning of each reporting year. Since the initial reporting period began mid-way through one growing season and extended part way into another, a special growth procedure was applied based on research by the California Division of Forestry at nearby Jackson State Demonstration Forest on seasonal growth patterns. The median plot measurement date at Hollow Tree was August 7, at which time 22% of the growing season remains. By June 13, the end of the initial reporting period, 54% of the growing season has passed. To estimate the change in onsite carbon stocks due to tree growth, therefore, we "grew" the inventory using CRYPTOS for 1 year and added 76% of the year's growth to the initial carbon stocks. Growth in the initial inventory during the initial reporting period was calculated to be 108,241 tonnes CO₂e. Initial carbon stocks plus growth during the reporting period comes to 5,631,770 tonnes.

Depletions during the initial reporting period were calculated based on the harvested net board feet from the mill tally report and ratio estimators for carbon in harvested trees, carbon in logs delivered to the mills, and carbon removed in non-commercial trees. Total depletions calculated in this way comes to 73,996 tonnes.

The total onsite MTCO₂e at the end of the reporting period is 5,557,774 (Table 17).

Table 16 Summary of inventory stocks for each pool at the end of the reporting period for Hollow Tree project (Forest Offset Protocol §9.1.1.1 (23); §9.2.1 (6).

Carbon Stock Pool	Average MTCO₂e / Ac	Total MTCO₂e
IFM - 1 standing live (includes below ground)	268.30	5,446,621
IFM - 3 standing dead (includes below ground)	5.48	111,153
IFM - 7 carbon in in-use forest products	0.14	2916
IFM - 8 carbon in landfills	0.09	1882
IFM - 14 biological emissions / removals from change in harvesting on forestland outside project area	0.27	5401
IFM - 17 biological emissions from decomposition of forest products		<i>Included as a component of carbon stored in harvested wood products</i>
Total		5,567,973

6.1.1 Inventory Confidence Statistics (Forest Offset Protocol §9.1.1.1 (24)); §9.2.1 (7))

MRC utilized a two-stage sampling methodology to select inventory sample plots. Public land survey sections were randomly selected until sections representing 25% of the project area had been selected. A 5 by 10 chain grid with a random starting point was laid on the selected sections; the grid intersections defining sample plot locations. In terms of two-stage sampling, the sections comprised the primary sample and the plots comprised the secondary sample. The mean and standard error of total plot carbon was calculated following procedures under “Two-stage Sampling with Unequal Sized Primaries” in Freese, 1962 (see references). Since Freese’s methodology only accounts for variation between primaries, we calculated the standard error within primaries and added to the between-primary standard error using what some biometricians refer to as “Bruce’s approximation”. The standard error of total carbon calculated using these procedures is 117,946 tonnes.

Calculation of the confidence deduction follows section A.4 of the Forest Offset Protocol. Since the calculated sampling error, 2.14% is less than 5%, a confidence deduction is not required.

6.2 Estimate of Harvest Volumes and Associated Carbon in Harvested Wood Products (Forest offset Protocol §9.2.1 (11) (12)).

The calculation of the actual carbon in harvested wood products begins with the reported net harvest volumes delivered to the mill from the project area during the initial reporting period. MRC tracks all mill deliveries by a source code value that links each load to a particular THP and yarding method. The harvest volume report for Hollow Tree during the initial reporting period is summarized in Table 17 below.

Table 17 Net conifer harvest volume delivered to the mill (MBF scribner) during the initial reporting period.

Species	Volume delivered (mbf)
RW	495
DF	2,131
WW	19
Total	2,645

MRC's harvest tracking system does not produce a direct estimate of cubic foot harvest volume, however our planning model calculates carbon in harvested wood products (CHWP) and harvested board foot, Scribner (HBF). We developed a ratio estimator for CHWP / HBF from the baseline modeling for partial cut regimes similar to MRC's actual practices. CHWP was calculated using this ratio estimator applied to the actual board foot harvest. The CHWP estimate was then input into the calculation procedures for harvested wood products defined in Appendix C of the Forest Offset Protocol, beginning with step C.2.

The values for the current reporting period 2,916 tonnes in in-use products and 1,882 tonnes in landfills.

6.3 Promotion of onsite carbon stocks (Forest offset protocol §3.8.3)

The project will maintain and increase existing carbon stocks during the term of this project. It is possible, that during a 10-year period there may be a decline in standing live carbon stocks due to transitioning to uneven-aged management and reducing tanoak density on the project area. The "sustained yield" legal requirement that is part of the California Forest Practice Rules

(14 CCR 913.11) ensures that harvest levels can be sustained over a long-term (100 year) period.

6.4 Projections of Baseline and Actual Harvest Volume from Project Area over 100 year period (Forest Offset Protocol § 9.2.1 (20))

MRC's Option A plan, approved by Cal Fire, includes a 100 year projection of harvest and growth. The equivalent average annual harvest for the Hollow Tree project area under the Option A plan is 6,538 MBF. The average annual harvest for the baseline scenario is 7,830 MBF. Over the 100 year project life time, assuming that the Option A harvest rates continue into 2115, the actual harvest volume is projected to be 653,800 MBF, and the project baseline harvest over the 100 year baseline scenario is 783,000 MBF.

7. Calculation of GH reductions and removals (Forest Offset Protocol §9.2.1 (16) (19))

Calculation of GHG removals was performed in accordance with the requirements of the Carbon Offset Protocol – US Forest Projects.

Table 18 Calculation of GHG removals based on COP Improved Forest Management worksheet calculated for project area.

Hollow Tree			Rpt period
Project start date		6/4/2015	1
Reporting Period Begin			6/4/2015
Reporting Period End			6/13/2016
Onsite Carbon Stocks		5,523,529	5,557,774
	Growth	108,241	
	Depletions	73,996	
Confidence Deduction			0%
Adjusted onsite C stocks			5,557,774
Baseline Carbon Stocks			4,727,795
Quantified GHG Reductions			829,979
Actual Carbon in trees harvested for WP			15,680
Baseline Carbon in trees harvested for WP			42,685
Actual Carbon in wood delivered to mills			9,403

Baseline Carbon in wood delivered to mills			25,554
Actual Carbon in WP, excl landfills			2,916
Actual Carbon in WP, incl landfills			4,798
Baseline Carbon in WP, excl landfills			7,924
Baseline Carbon in WP, incl landfills			13,040
Diff between Actual and BSL CHWP, excl landfills			(5,008)
Diff between Actual and BSL CHWP, incl landfills			(8,242)
Diff in Actual and BSL CHWP, landfill adj			(8,242)
Diff in CHWP, w/ market response			(6,593)
Diff between Actual and BSL Carbon in harvested trees			(27,005)
Secondary Effects			(5,401)
Net GHG Reductions			817,984
Cumulative Net GHG Reductions			817,984
Negative Carryover			0
CRTs issued prior to buffer or adjustment for reversal			817,984
Reversal Risk Rating			19.24%
Buffer Pool Contributions			157,349
CRT's issued to account holder			660,635

8. Reversal Risk Rating (Forest Offset Protocol § 7, Appendix D; (27) § 9.2.1 (18); § 9.1.1.1 (27); § 9.2.1 (18))

8.1 Reversal Risk Rating by Category

Table 19 Calculation of reversal risk for project area and buffer pool contribution.

Risk Category	Private ownership
Financial Failure	5%
Conversion	2%
Over-harvesting	2%
Social	2%
Wildfire	4%
Disease/Insect	3%
Other catastrophic	3%
Total buffer pool contribution	19.24%

8.2 Project Reversal Risk Rating (Forest Offset Protocol § 9.1.1.1 (27); § 9.2.1 (18))

The Project's reversal risk rating is calculated as follows (Section D.5 of the Forest Offset Protocol).

$$100\% - (((1-0.07)*(1-0.02)*(1-0.02)*(1-0.02)*(1-0.04)*(1-0.03)*(1-0.03)*100)) = 19.24\%$$

Key References

Climate Action Reserve. 2014. Quantification Guidance for Use with Forest Carbon Projects. January 21, 2014.

Freese, Frank. 1962. Elementary Forest Sampling. USDA Forest Service Agriculture Handbook No.. 232.

Krumland, Bruce and Eng, Helge. 2005. Site Index Systems for Major Young-Growth Forest and Woodland Species in Northern California. California Department of Forestry & Fire Protection. California Forestry Report No. 4.

Krumland, Bruce and Eng, Helge. 2005. CA_SIMServer Source Code. California Department of Forestry and Fire Protection. Website:

http://www.fire.ca.gov/resource_mgt/resource_mgt_stateforests_publications_reports_sitereports.

Krumland, Bruce. 2011. Using FORSEE Growth model DLLs as Stand Alone Objects. California growth and yield modeling cooperative. Website: <http://www.cagym.com>.

Hanson, Erica, J; Azuma, David L; and Hiserote, Bruce, A. 2002. Site Index Equations and Mean Annual Increment Equations for Pacific Northwest Research Station Forest Inventory and Analysis Inventories, 1985 – 2001.

PART XII. ATTESTATION AND OPO/APD SIGNATURE			
I certify under penalty of perjury under the laws of the State of California the GHG reductions and/or GHG removal enhancements for			
Project Name: Hollow Tree – CAR1191			
from		Reporting Period Start Date: 06/04/2015	to
		Reporting Period End Date: 06/13/2016	
are measured in accordance with the Compliance Offset Protocol			
Check the appropriate Compliance Offset Protocol:			
☐ U.S. Forest Projects, October 20, 2011,			
☒ U.S. Forest Projects, November 14, 2014,			
and all information required to be submitted to ARB is true, accurate, and complete.			
In signing this form, I certify under penalty of perjury of the laws of California that the information contained in this form is true, accurate, and complete. I further certify that I am duly authorized to represent and legally bind the Offset Project Operator (OPO) on all matters related to this form.			
SIGNATURE:		PRINTED NAME: Dennis Thibeault	
TITLE: Executive Vice President, Forestry		DATE: 6/15/17	