NORTH COAST RESOURCE PARTNERSHIP

CARBON INVENTORY ESTIMATES FOR THE NORTH COAST RESOURCE PARTNERSHIP

Prepared by:
John Nickerson
Dogwood Springs Forestry

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INTRODUCTION

The North Coast Resource Partnership (NCRP) is working to develop a regional plan focused on strategies to enhance the economic, environmental and community vitality of the North Coast region. This document presents an inventory estimate of carbon stocks in landcover classes throughout the study area. The study area is shown in Figure 1.

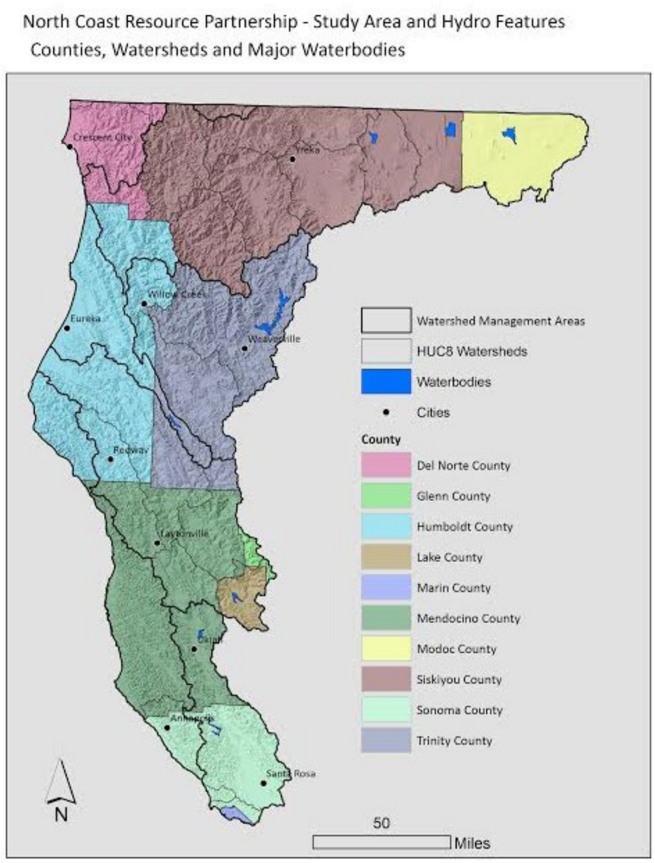
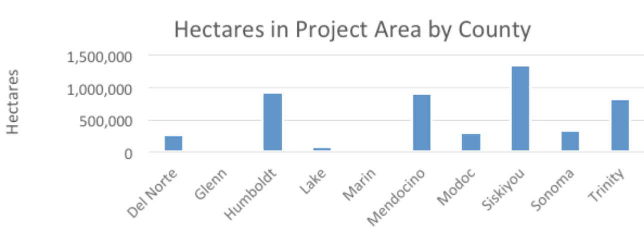


Figure 1. The NCRP study area included in this report.

The boundaries of the study area are defined by watershed boundaries, not by county boundaries. Hence, only portions of certain counties are included in the analysis. Table 1. displays the area by county within the study area.

Table 1. Area by county within the study area.



METHODOLOGICAL APPROACH

The inventory approach is focused on quantifying carbon in the major biological reservoirs described in this document. Inventory estimates are provided for each landcover class within the study area. The inventory approach tiers from, and adds to, a statewide inventory developed by the California Air Resources Board. The resolution of the inventory estimates, therefore, is generally derived from statewide estimates. The approach to the inventory estimates is based on data sources of varying resolutions and is unable to detect nuanced changes in inventories due to management interventions, such as increased carbon stocks in soil inventory due to improved agricultural management. No effort was made to calculate confidence statistics in the inventory estimates within the study area.

Inventories of biomass in trees, shrubs, and grasses are typically developed by first estimating volume in the plant material and converting the volumetric estimates to carbon estimates by adjusting based on the density and the moisture content of the plant material. Carbon values are often converted to Carbon Dioxide Equivalent (CO_2e) values since we are most concerned with the role plants have from a climate perspective, in the event they are released to the atmosphere from decay or burning or in sequestering CO_2. CO_2e is a standard to which all greenhouse gases (including methane, nitrous oxide, and others) are converted to reflect the global warming potential of a given amount of a greenhouse gas. Carbon inventories are presented in this section as Carbon Dioxide Equivalent (CO_2e).

Carbon dioxide equivalency is a quantity that describes, for a given mixture and amount of greenhouse gas, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a specified timescale (generally, 100 years). Carbon dioxide equivalency thus reflects the time-integrated radiative forcing of a quantity of emissions or rate of greenhouse gas emission—a flow into the atmosphere—rather than the instantaneous value of the radiative forcing of the stock (concentration) of greenhouse gases in the atmosphere described by CO_2e. CO_2e is commonly expressed as metric tonnes. Greenhouse gases other than CO_2e are not included in this inventory approach. Table 2 displays the conversions used within the inventory approach.

Table 2. Conversions used in the inventory approach.

Base Unit	Conversion	Rationale		Final Unit
Biomass	.5 * biomass	The carbon content of biomass is almost always found to be between 45 and 50% (by oven-dry mass).*		Carbon
Carbon	3.67 * carbon	The conversion is based on the fractional portion of carbon, by weight, in a molecule of carbon dioxide.	=	CO_2-e
Tons	0.90718474 * tons	Conversion of short tons to metric tons.		Metric Tons (MT) or Tonnes

* Schlesinger, W.H. 1991. Biogeochemistry: An Analysis of Global Change. Academic Press, San Diego. 443 p. (Fifth printing, 1995)

All reports are provided on a per hectare basis unless otherwise specified. The biological inventory is developed to represent inventory estimates of CO_2e for 2014. The inventory development process leans heavily on LANDFIRE data. Since the last LANDFIRE data was developed for 2010, we 'grew' forest estimates to reflect growth between 2010 and 2014 for forest vegetation. This is described in the subsection on forests.

INVENTORY BASIS

The State of California enacted the Global Warming Solutions Act in 2006, which requires the California Air Resources Board (ARB) to set statewide Greenhouse Gas (GHG) emission limits, to develop regulations to reduce emissions, and to periodically inventory GHG emissions and removals, including emissions and removals from natural and working landscapes.

The inventory methodology builds from work that was conducted previously under agreement with ARB (Agreement #10-778) in which Battles *et al* (2014) used LANDFIRE as the basis for stratifying California's vegetation and developed biomass estimates for the above-ground standing portion of natural and working landscapes. The approaches to developing biomass estimates for LANDFIRE vegetation classifications is explained in Gonzalez et al (2015) and varied based on whether the vegetation was forest, shrubs, or non-woody vegetation. For forests, regression estimators were developed from biomass estimates from Forest Service FIA plots, with exact coordinates intersected with LANDFIRE pixels, and used both size and density of forest vegetation as variables. Aboveground shrub biomass was developed by analysis of data available from LANDFIRE and other published sources. Where data was unavailable for a specific shrub type, the shrub types were included in a broader stratification with shrub classes that did have data. For non-woody classes (mostly grasses), biomass estimates were derived from estimates of net primary production.

Saah *et al* (2016)[1] provided further analysis to refine the Battles and Gonzalez work by improving the estimates of dead biomass pools and 'growing', or updating the biomass inventory reported in Battles work to address growth in forest inventories resulting in a statewide inventory and database.

The result of Saah's efforts led to the development of GIS raster layers and geodatabases which can be linked together to spatially project the biomass estimates for every 30-meter pixel in the raster dataset. The inventory estimate developed for the NCRP uses the data and procedures from Saah, 2014 as the basis for inventory development. As part of the NCRP inventory, we have refined several areas within the Saah report to better align the inventory process currently underway with the California Department of Conservation for Merced County. The Merced County work is a GHG accounting framework that is being developed at a jurisdictional scale. A GHG baseline is being developed for the land use sector in Merced that will enable the implementation of discrete actions aimed at reducing emissions to be quantified at the county scale. The effort is built on a similar effort that was piloted in Sonoma County. The jurisdictional approach offers considerable advantages over efforts to quantify GHG reductions only at the project level by enabling the assessment of the scope and causal drivers of emissions sources and providing a better platform for strategic planning of priority actions. Additionally, the ability to monitor leakage is improved with the jurisdictional approach. The areas of refinement include:

- Soil carbon has been added to the inventory estimate using a national dataset. On landcover types where soils are repeatedly disturbed, such as with row crops, orchards, vineyards, and urban forests, the underlying soil carbon estimates have been discounted from their reported values based on interpretations from literature review.
- The Battles inventory estimates for forests have been 'grown' or updated using the approach outlined by Saah (2016) to 2010. This effort is described in the forest subsection below.
- Urban forests have been defined through geoprocessing (described in the urban forest subsection) to explicitly address only those areas that are highly dense in terms of housing and other structures. Additionally, urban forests within these areas have been sampled independently, as described in the urban forests subsection, for each county to derive and urban forest biomass estimate.

1 Saah D., J. Battles, J. Gunn, T. Buchholz, D. Schmidt, G. Roller, and S. Romsos. 2015. Technical improvements to the greenhouse gas (GHG) inventory for California forests and other lands. Submitted to: California Air Resources Board, Agreement #14-757. 55 pages.

- The LANDFIRE vegetation classes have been organized to align with landcover classes being used concurrently by the California Department of Conservation's jurisdictional accounting2 development in Merced County.

STRATIFICATION OF THE CARBON INVENTORY

This inventory report includes carbon stocks as CO_2e within the study area. It does not include other Greenhouse Gases such as methane and nitrous oxide. The base unit of inventory in the ARB statewide inventory is the combination of the LANDFIRE vegetation community definition (EVT), the height class (EVH), and the density class (EVC). For a given combination of EVT, EVH, and EVC, the non-soil carbon estimates are the same.

Soil carbon estimates are added to the database developed for this report which, then, adds another permutation layer to the inventory classification. Each of the EVTs has been grouped into a Landcover Class and a Sub-Landcover Class, which have been defined as part of this inventory effort to improve the ability to report the LANDFIRE classes. The full classification scheme is provided in Appendix A.

The inventory estimates are developed from sources that are publicly available. Apart from the urban forest estimate, the stratification of landcover classes was derived directly from LANDFIRE and much of data used to develop this report was based on the previous Saah and Battle data mentioned above. The Landcover Classes used in this report are shown in Table 3.

Table 3. Landcover classes and landcover subclasses included in this report.

Landcover	Landcover subclass	Landcover	Landcover subclass
Barren	Barren	Urban The urban forest suite of EVTs is broad and based on the LANDFIRE EVT definitions found within the area defined as urban area. This is described in greater detail in the urban forest section.	Agroforestry
	Roads		Barren
	Snow		Coniferous Forest
	Water		Grassland
Forest	Coniferous Forest		Juniper Woodland
	Juniper Woodland		Low Intensity
	Ruderal Deciduous Forest		Other Urban
	Ruderal Evergreen Forest		Other Urban Forest
	Ruderal Mixed Forest		Other Urban Grassland
	Woodlands		Other Urban Shrubland
Grassland	Grassland		Roads
	Ruderal Grassland		Row Crop
Orchard	Orchard		Ruderal Grassland
Row Crop	Agroforestry		Shrubland
	Row Crop		Vineyard
Shrubland	Ruderal Shrubland		Water
	Shrubland		Woodlands
Vineyard	Vineyard		Developed
Wetland	Wetland		

GREENHOUSE GAS ACCOUNTING BOUNDARIES AND DATA SOURCES

The data available from the ARB inventory database is presented in tonnes (metric tons) of biomass and converted to CO_2-equivalent using the formula presented at the beginning of this report. The base sources of data used to generate the estimates in this report vary. The methods used are described in detail in the methodological description for each landcover class. Table 4 provides a comprehensive list of carbon pools (individual physical units of carbon storage) by landcover type included in this report and the data sources used to develop the carbon estimates.

2 Jurisdictional accounting is a carbon accounting platform that operates at the level of political jurisdictions, such as a county, a collection of counties, or a state. It is characterized by its large scale compared with "activity"-level carbon accounting. Activity-level accounting assesses the amount of the carbon sequestered by discrete parcels of land, typically where land managers are undertaking activities designed to increase carbon sequestration. Jurisdictional and activity-level accounting systems are complementary. The jurisdiction serves as the backstop for accounting estimates at the activity level.

Table 4. CO_2-e assessment boundaries in the Inventory methodology.

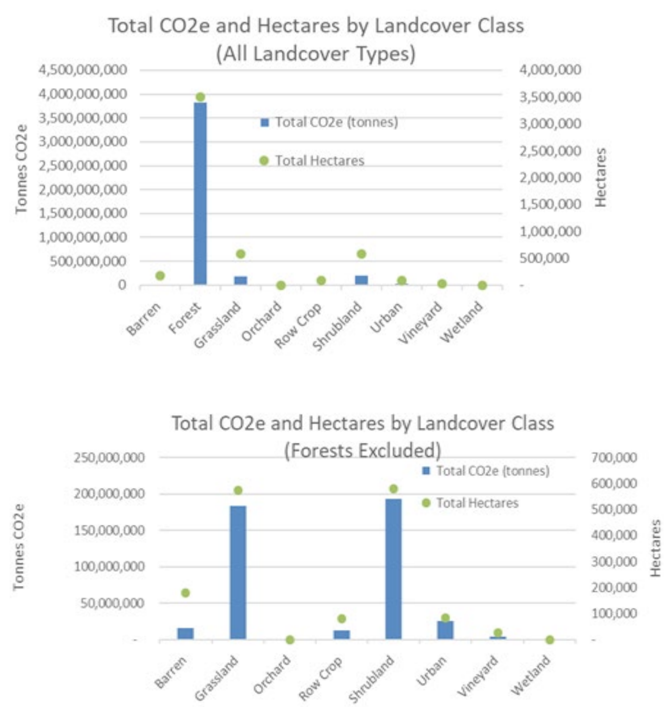
Landcover Type	Carbon Pool Unit and Greenhouse Gas Included							
	Standing Live and Dead Trees CO2	Soil CO2	Downed Woody Debris CO2	Litter and Duff CO2	Shrubs CO2	Herbaceous CO2	Harvested Wood Products CO2	Landfill CO2
Barren		1						
Forests	2	1	2	2	2		7	7
Grasslands		1				3		
Orchards		1						
Row Crop		1						
Shrubland		1			2			
Urban	4/5/6	1						
Vineyard		1						
Wetland		1						
		Included						
		Not Included						

Data Reference	Data Source
1	Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed January 10, 2017
2	Saah D., J. Battles, J. Gunn, T. Buchholz, D. Schmidt, G. Roller, and S. Romsos. 2015. Technical improvements to the greenhouse gas (GHG) inventory for California forests and other lands. Submitted to: California Air Resources Board, Agreement #14-757. 55 pages.
3	Estimated from literature review.
4	Geoprocessing conducted to define 'Urban Area' conducted by Tukman Geospatial.
5	Canopy estimation with iTree Canopy tools conducted for each county.
6	Carbon ratio estimators from CalFire report.
7	California timber yield tax

RESULTS

Forest cover dominates the landcover classes within the study area. Approximately 3.5 million hectares, or almost 70% of the surface area within the study area are in forest cover. Forests also store the most amount of carbon with almost 4 gigatonnes of CO_2e (or 90% of the carbon within the study area) is in forests. The next closest landcover types, in terms of surface area, are grasslands and shrublands. Figure 2 displays the area and CO_2e associated with each landcover class within the study area. Since forests dwarf other landcover classes in terms of area and CO_2e, the figure has been presented with and without forests to show the relative contribution of other landcover classes. The majority of landcover areas within the study area remain in non-developed landcover classes

Figure 2. Total estimated CO2e and area associated with each landcover class within the study area.



Landcover classes that contain woody material have a greater proportion of their carbon in non-soil reservoirs. Forests, for example, store substantial portions of carbon in trees, both in above-ground and below-ground portions (roots), lying dead wood, litter, and duff and a smaller proportion in soils. In landcover classes that don't have as much woody material, the bulk of the carbon is stored in soils. In terms of carbon densities, forests and wetlands contain high amounts of carbon per hectare compared to other landcover classes. Since Landfire only identified 5 hectares of wetlands within the study area, confidence in the estimates of carbon density and how it is stored is low. Additionally, the carbon densities in forests within the study area are among the highest in the United States[3]. Figure 3 displays the estimates of CO_2e per hectare by soil and non-soil reservoirs by landcover class.

Figure 3. Estimates of soil and non-soil CO_2e by landcover class.

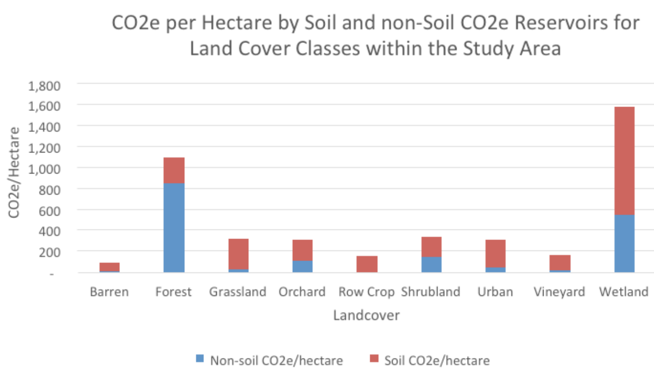
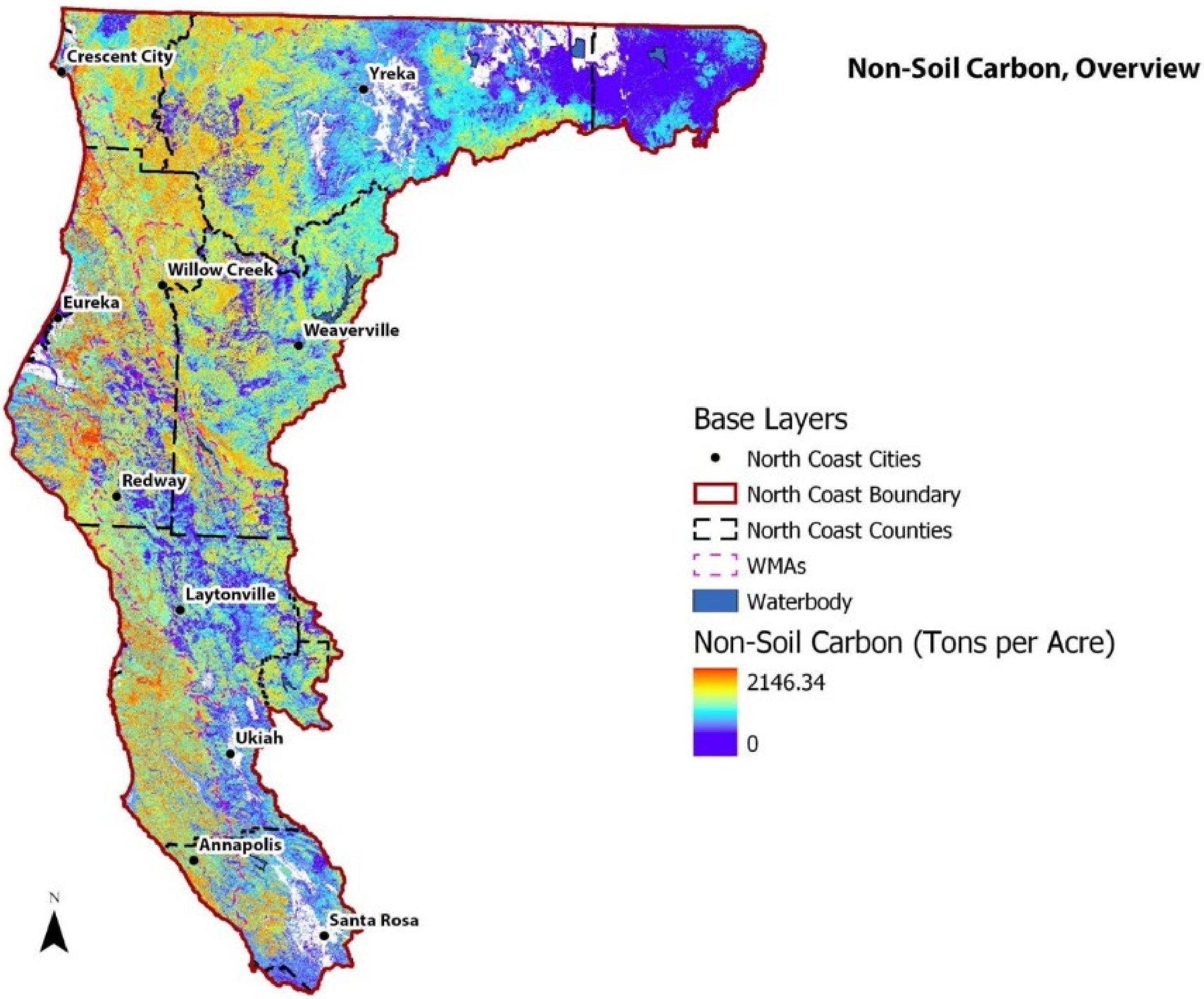


Figure 4 displays a map of above-ground carbon within the study area. It can be observed that the highest concentrations of carbon are within the redwood belt, particularly in state and national parks, as well as Jackson State Forest. Grassland areas, located in the valleys of the North Coast and widespread in Modoc County, generally contain substantially lower amounts of above-ground carbon.

3 Air Resources Board Assessment Area Data File (https://www.arb.ca.gov/cc/capandtrade/protocols/usforest/usforestprojects_2015.htm)

Figure 4. Map of above-ground carbon stocking within the study area.



The balance of this report summarizes the approach used to develop the inventory estimates by carbon reservoir. The following reservoirs and landcover classes are summarized (in order):

- Soils
- Barren
- Forest
- Grassland
- Orchard
- Row Crops
- Shrubland
- Urban
- Vineyard
- Wetland
- Harvested Wood Products

SOILS

Soils are a component of every landcover type. Soils are not included in the ARB database and were determined for this analysis. Estimates of soil CO_2e were calculated by intersecting spatial data from a national soils inventory developed by the Natural Resources Conservation Service (NRCS)[4] referred to as SSURGO data, with the LANDFIRE strata that includes landcover, size and density attributes. The publicly available soil survey contains estimates of soil carbon for each soil class in the survey. The soil carbon inventory estimates were determined by using the values provided for soil organic matter values and soil bulk density values in the SSURGO database for the study area.

The soil organic carbon estimates were calculated in terms of metric tonnes per acre acre and converted to CO_2e, as described in "Quantification Guidance for Use with Forest Carbon Projects[5]", using Equation 2.1 from the quantification guidance associated with the Climate Action Reserve's Forest Carbon Protocol, Version 3.3[6], as shown below.

Equation 2.1 from Climate Action Reserve's Quantification Guidance for Forest Carbon Projects.

Soil CO_2e per Acre Soil CO_2e = Organic Matter Value (Steps 2 or 4) x 0.58 (Conversion of Organic Matter to Carbon) x Bulk Density Value (Steps 3 or 5) x Soil Depth Sampled (30 cm) x 40,468,564.224 (Conversion of 1 cm^2 to 1 acre) x 10-6 (Conversion of 1 gram to 1 metric ton) x 3.67 (Conversion of Carbon to CO_2)

The resolution of soil carbon estimates in the SSURGO data is broad and does not account for soil carbon associated with landscapes that have been heavily modified through management activities, such as with agriculture and urban development. VandenBygaart et al (2003)[7] indicate losses of soil carbon associated with conversion of natural landcover types to agriculture or urban use with widely varying estimates of losses. For soils associated with urban, barren, and agricultural landcover types, soil estimates were adjusted as part of this analysis to 50% of the NRCS estimates to reflect the decline in soil carbon as the result of enhanced decomposition associated with conversion. Soil carbon was quantified for all LANDFIRE cover classes in the study area. The soil carbon estimates calculated for each landcover class remained constant for historical and projected estimates. Estimates of soil carbon are summarized in Table 4 in an earlier section in this report.

4 http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/

5 http://www.climateactionreserve.org/how/protocols/forest/dev/version-3-3/

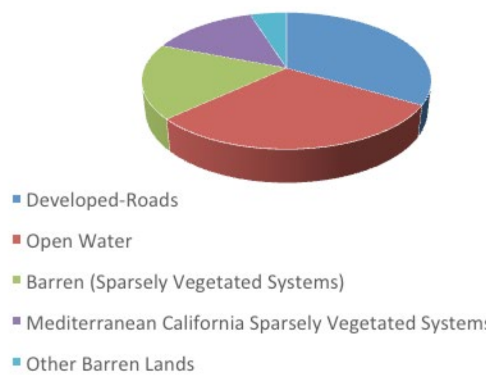
6 http://www.climateactionreserve.org/how/protocols/forest/

7 https://www.researchgate.net/publication/216805000_Measuring_Change_in_Soil_Organic_Carbon_Storage

BARREN LANDSCAPES

Barren landscapes are landscapes with little or no vegetation. They include landcover such as roads, open water, and other barren landscapes. These landscapes contain less than 4% of the surface area and contain less than 1% of the carbon stocks within the study area. Figure 5 displays the relative proportion of barren landscapes within the study area.

Figure 5. Relative proportion of barren landscapes within the study area.



FORESTS

Forests include coniferous and woodland forests within the study area. The two distinct forest types comprise nearly 70% of the landcover in the study area and approximately 90% of the carbon in natural and working landscapes within the study area. Forests also contain nearly three times the amount of carbon on a per hectare basis compared to the next closest landcover type, with the exception of wetlands (see Table 4). Most of the carbon (~77%) in forest landcover types is held in non-soil biomass in the form of above and below-ground (roots) live and dead trees, lying dead wood, litter, and duff.

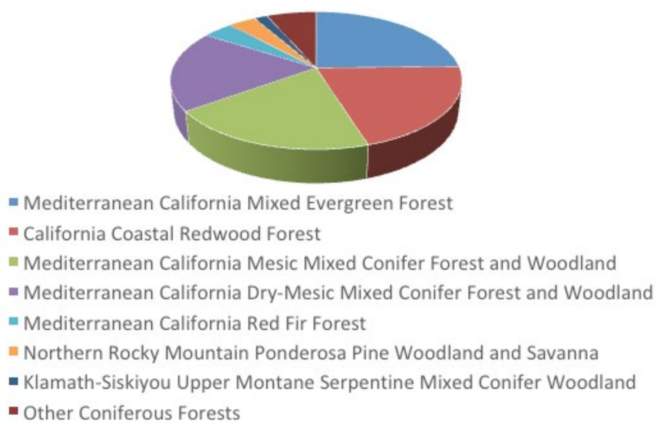
Forests are identified by forest community in the LANDFIRE data and are further divided by tree height classes and density classes. The most important forest class, in terms of carbon stocks, are the coniferous forests. Coniferous forests constitute the greatest land area and contain the greatest amount of CO_2e per hectare of any landcover type with the exception of wetlands, which only constitute a tiny fraction of landcover area within the study area (5 acres). Coniferous forests comprise approximately 85% of the forest area within the study area. Woodlands, mostly containing oaks and other hardwood species comprise approximately 14% of the forested area. Table 5 displays the carbon and surface area data for forest landcover subclasses.

Table 5. CO_2e and surface area data for forest landcover subclasses.

Landcover Subclass	Total CO2e (tonnes)	Non-soil CO2e (tonnes)	Soil CO2e (tonnes	Total Area (Ha)	Total CO2e/ Ha (tonnes)
Coniferous Forest	3,468,427,596	2,704,461,232	763,966,364	2,975,774	1,166
Juniper Woodland	12,350,256	9,248,468	3,101,787	22,737	543
Ruderal Deciduous Forest	56	2	54	0	155
Ruderal Evergreen Forest	2,162	45	2,117	8	283
Ruderal Mixed Forest	1,663	32	1,630	5	303
Woodlands	348,186,832	246,424,730	101,762,102	504,316	690

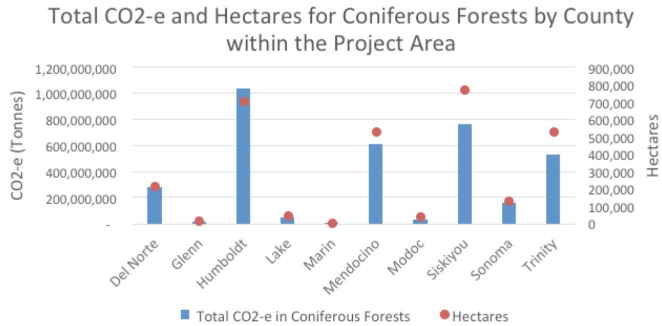
LANDFIRE recognizes 59 different forest communities within the study area. 28 of these communities are identified as coniferous forest communities. The relative significance of these communities, in terms of land area is shown in Figure 6.

Figure 6. Proportion of the coniferous forest communities within the study area.



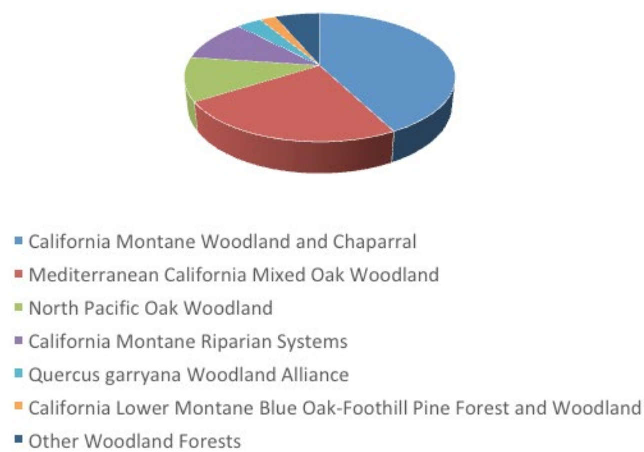
Forests are irregularly distributed across the study area. Humboldt, Mendocino, Siskiyou, and Trinity Counties contribute the bulk of the coniferous forest area and forest carbon, as shown in Figure 7.

Figure 7. Distribution of coniferous forest by area and CO_2e by county.



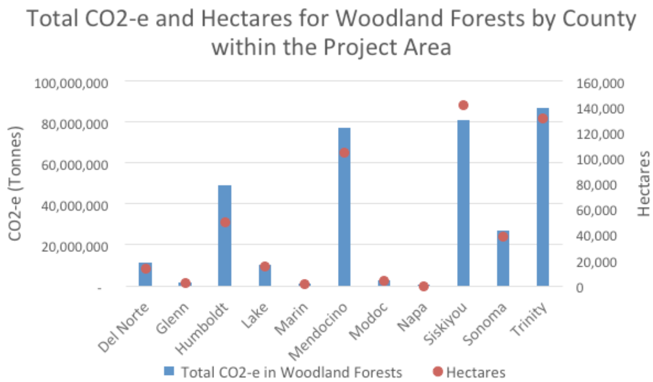
Woodland forests comprise approximately 14% of the area identified as forest by LANDFIRE. There are no separate woodland subclasses for woodland forests, but LANDFIRE recognizes 24 different woodland communities. Figure 8 displays woodland forests as a proportion of all woodland forests, by area, within the study area.

Figure 8. Proportion of the woodland forest communities within the study area.



Similar to coniferous forests; Humboldt, Mendocino, Siskiyou, and Trinity have the greatest area and carbon stocks associated with woodland forests. Figure 9 displays the woodland forests by county and carbon stocking within the study area.

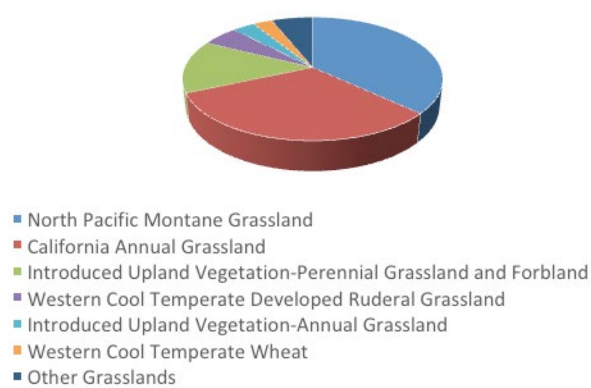
Figure 9. Area and carbon stocks within woodland forests by county within the study area.



GRASSLANDS

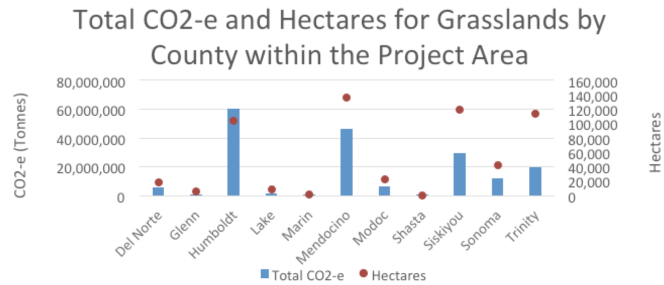
LANDFIRE recognizes 20 different communities of grasslands within the study area. Grasslands constitute approximately 12% of the study area and contain approximately 4% of the carbon in the natural and working landscapes. Most of the carbon in grassland ecosystems is found in the soil. Figure 10 shows the relative proportion of the dominant grassland communities within the study area.

Figure 10. Relative proportion of grassland communities by surface area within the study area.



Most of the grassland areas are found in Humboldt and Mendocino Counties within the study area, as shown in Figure 11.

Figure 11. Area and carbon stocks within grasslands by county within the study area.



ORCHARD

LANDFIRE recognizes two classes of orchard within the study area; Western Cool Temperate Orchard and Western Warm Temperate Orchard. Orchards constitute approximately 36 hectares or less than 1% of the study area and contain less than 1% of the carbon in the natural and working landscapes within the study area. The majority (64%) of carbon within the orchard landcover class is estimated to be in the soil carbon pool. Approximately 70% of the landcover classified as orchard by LANDFIRE within the study area is found in Mendocino County. Siskiyou County has the next highest proportion at 16% of the study area.

ROW CROP

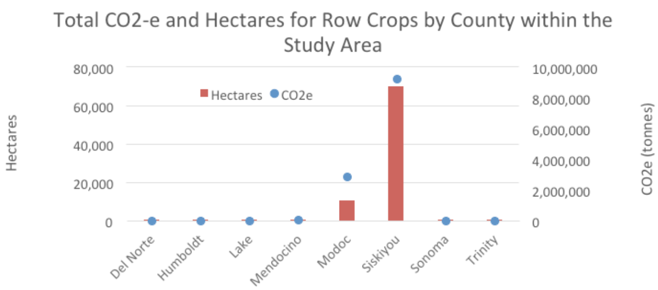
LANDFIRE recognizes 14 different classes of row crops within the study area. The communities are split between row crops associated with agroforestry system and general row crops. The row crops associated with the agroforestry systems constitute a small proportion (<1%) of the area identified as row crop within the study area. The row crops in general constitute approximately 1.6% of the land classes within the study area and contain less than 1% of the carbon in the study area. The carbon in the row crop landcover class is mostly (>99%) within the soil pool. Table 6 shows the row crop classes that are not associated with agroforestry systems.

Table 6. Landfire row crop classes within the study area.

Row Crop Class	Hectares
Western Cool Temperate Close Grown Crop	47,298
Western Cool Temperate Fallow/Idle Cropland	13,174
Western Cool Temperate Row Crop	6,379
Western Cool Temperate Row Crop - Close Grown Crop	21
Western Warm Temperate Close Grown Crop	10,575
Western Warm Temperate Fallow/Idle Cropland	2,975
Western Warm Temperate Row Crop	159
Western Warm Temperate Row Crop - Close Grown Crop	0

The majority of row crops within the study area are found in Modoc and Siskiyou Counties, as shown in Figure 12.

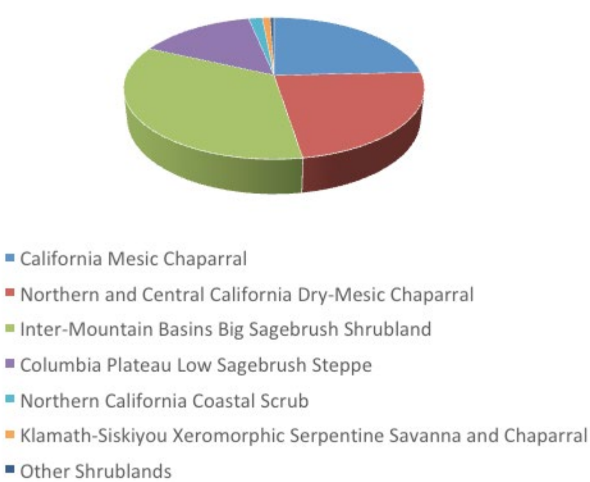
Figure 12. Total carbon and landcover area associated with row crops within the study area.



SHRUBLAND

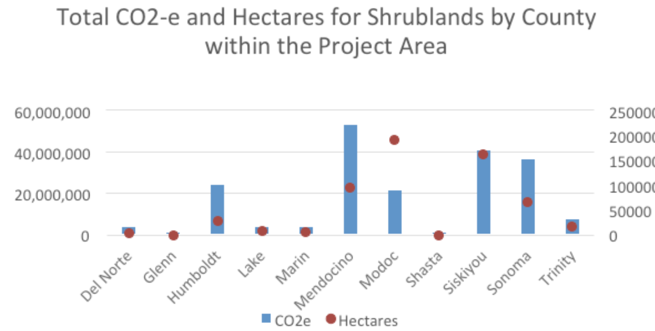
LANDFIRE recognizes 22 different communities of shrublands within the study area. Shrublands constitute approximately 580,000 hectares or 12% of the study area and contain approximately 5% of the carbon in the natural and working landscapes. Figure 13 shows the relative proportion of the dominant shrubland communities within the study area.

Figure 13. Relative proportion of shrubland communities by surface area within the study area.



The majority of shrublands within the study area are found in Mendocino, Siskiyou, and Sonoma Counties. Humboldt, Modoc, and Trinity Counties contribute a substantial amount of area in shrub landcover as well. Figure 14 display the carbon stock densities and area associated with shrublands, by county, within the study area.

Figure 14. Area and carbon stocks within shrublands, by county, within the study area.



URBAN

The urban area contains carbon in trees (urban forests), shrubs, herbaceous material and soils. Urban forests provide a myriad of benefits beyond carbon sequestration. They also improve air quality, beautify urban areas, increase property values, reduce flooding and water pollution, calm traffic, reduce crime, improve habitat, reduce energy consumption, and even promote exercise[8].

Urban areas comprise less than 2% of the surface area within the study area and less that 1% of the carbon within the study area. Unlike many other aspects of developing the inventory estimates through use of existing data, urban forests required independent analysis to derive a carbon estimate.

The methodological approach to developing an estimate of CO_2e in urban areas followed the following steps, each of which is described in greater detail in this section:

1. Define the extent of the urban forest area in highly-developed areas (UFHD).
2. Develop an estimate the tree canopy area within the UFHD.
3. Apply a carbon ratio estimator to the canopy area estimate.
4. Combine estimates with LANDFIRE-attributed 'urban' pixels outside of the UFHD.

Defining the Urban Forest Area in highly-developed areas (UFHD)

The following steps were used to develop the UFHD extent:

1. LANDFIRE 30-meter raster data attributed with 'Developed' in the 'EVT' field were

8 Friends of the Urban Forest, Greening San Francisco. https://www.fuf.net/benefits-of-urban-greening/. 2017

extracted from the LANDFIRE dataset. The developed classes included:

   a. Developed-Roads
   b. Developed-Upland Deciduous Forest
   c. Developed-Upland Evergreen Forest
   d. Developed-Upland Herbaceous
   e. Developed-Upland Mixed Forest
   f. Developed-Upland Shrubland
   g. Developed-High Intensity
   h. Developed-Low Intensity
   i. Developed-Medium intensity
   j. Developed-Open Space

2. The raster data were converted to a polygon format and clipped to the 2010 US census area boundaries.
3. Small gaps of within the developed polygon that were not attributed with a 'Developed' prefix in LANDFIRE were assigned to the urban area polygon and are considered part of the urban area regardless of the LANDFIRE EVT they are attributed. This created the many sub-landcover classes within the urban landcover class.

The result of the analysis identified over 31,000 hectares within the UFHD throughout the study area. Table 7 shows the UFHD within each county within the study area. Counties not shown within the table are not shown because those counties did not contain the LANDFIRE attributes that triggered the geoprocessing effort that developed urban areas. All counties had additional pixels attributed by LANDFIRE as urban. These areas were combined with the areas identified as UFHD to develop the complete urban forest estimate.

Table 7. Landcover area assigned as UFHD by county within the study area.

County	Hectares
Del Norte	1,637
Humboldt	7,511
Mendocino	3,772
Siskiyou	1,026
Sonoma	17,169

Estimating the Tree Canopy Area within the UFHD

The United States Forest Service has developed an online tool that efficiently estimates the canopy area within a defined spatial extent. The tool is called i-Tree Canopy[9] and is publically available. The i-Tree Canopy tool assigns sequential random points within the spatial extent identified by the analyst, which in this case is the urban area. The points are intersected on a high resolution aerial photo which allows the user to label analyst-defined cover classes immediately under the point.

The cover classes included in this sample effort were tree (the point intersected with a tree canopy) or non-tree (something within the UFHD other than tree). The sampling effort was conducted independently for each county that had UFHD associated with it. Sample points were added until the statistical confidence in the canopy estimate exceeded (was less than) 10%@ 1 standard error.

The sampling effort resulted in a mean estimate of canopy area as a percentage of the entire UFHD. The percentages were multiplied by the area within the UFHD to calculate the canopy area in square meters. Table 8. shows the estimates of canopy area for each county within the UFHD.

Table 8. Canopy area estimates by county within the UFHD.

County	Canopy Cover %
Del Norte	25.0 %
Humboldt	20.9 %
Mendocino	20.5 %
Siskiyou	20.6%
Sonoma	22.2%

The canopy area was multiplied by urban transfer functions (carbon to canopy area ratios) developed for each climate zone in California[10]. All of the UFHD areas within the study area are in one climate zone. The estimated carbon to canopy area ratio within this climate zone is 77 tonnes CO_2e per hectare. The results are shown in Table x. These estimates were combined with the LANDFIRE estimates for additional urban areas (outside the UFHD), which totaled 51,768 hectares. The additional urban area outside the UFHD consist of other forest areas (27,383 ha), herbaceous areas (9,714 ha), and shrubland areas (14,660 ha). The results of this analysis is shown in Table 9.

9 http://www.itreetools.org/canopy/

10 Bjorkman, J., J.H. Thorne, A. Hollander, N.E. Roth, R.M. Boynton, J. de Goede, Q. Xiao, K. Beardsley, G. McPherson, J.F. Quinn. March, 2015. Biomass, carbon sequestration and avoided emission: assessing the role of urban trees in California. Information Center for the Environment, University of California, Davis.

Table 9. Estimates of area and carbon in urban areas within the study area.

County	Area (Ha)	Tree-related Carbon (CO2e tonnes)	Soil-related Carbon (CO2e tonnes)	Total Carbon (CO2e tonnes)
Sonoma	24,665	1,174,172	4,811,976	5,986,148
Humboldt	15,937	885,813	5,389,445	6,275,258
Siskiyou	15,827	445,384	3,336,790	3,782,174
Mendocino	14,674	755,626	4,142,075	4,897,701
Trinity	5,244	248,242	627,714	875,956
Del Norte	4,463	243,745	2,439,994	2,683,738
Modoc	1,394	16,664	451,021	467,685
Lake	376	21,463	54,935	76,398
Glenn	192	8,536	28,998	37,533
Marin	98	628	38,608	39,236
Tehama	3	148	215	363
Shasta	1	31	85	117
Colusa	0	26	50	77

VINEYARD

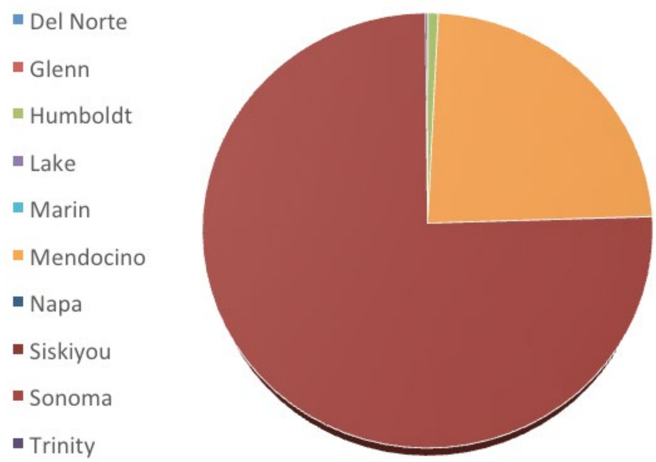
There are 26,648 hectares of vineyards within the study area with an average of 160 tonnes CO_2e per hectare. Upon review of the Landfire data for vineyards, it was apparent that the vineyard layer was underestimated. We integrated Cropscape data (2012) for vineyards as an alternative to Landfire. Cropscape is a national spatial dataset that is updated annually by the US Department of Agriculture using Landsat imagery. Cropscape is focused only on agricultural data and therefore is generally more accurate for agricultural data. Landfire identified small areas of vineyard outside of the Cropscape layer. These areas were retained as vineyard. Vineyards contain less than 1% of the surface area and contain less than 0.1% of the carbon stocks within the study area. Approximately 89% of the carbon in vineyard landscapes is estimated to be in the soil carbon pool. The effort resulted in three classes of vineyards within the study area. The major vineyard type is simply identified as Cropscape vineyard 2012. The two other vineyard types were from Landfire, as shown in Table 10.

Table 10. LANDFIRE vineyard classes within the study area by area.

Vineyard Class	Hectares
Cropscape Vineyards 2012	26,515
Western Cool Temperate Vineyard	44
Western Warm Temperate Vineyard	89

Most of the vineyard area within the study area is found in Sonoma and Mendocino Counties, although vineyards are found in small amounts throughout the study area, as shown in Figure 15.

Figure 15. Proportion of vineyards within study area by surface area.



WETLANDS

LANDFIRE identified very few hectares (< 5) associated with wetlands within the study area. Only one landcover class (North Pacific Swamp Systems) is recognized by LANDFIRE within the study area. Wetlands contain less than 1% of the landcover area and less than 1% of the carbon within the study area. However, wetlands are estimated to be the most carbon rich landcover classes, on a per-acre basis, within the study area. The majority of the carbon in the wetland cover class is found in the soil. The wetlands identified by LANDFIRE within the study area are found in Del Norte and Trinity Counties.

INVENTORY METHODOLOGY: CO_2-E IN HARVESTED WOOD PRODUCTS AND LANDFILLS

When trees are harvested for wood products, a portion of the carbon in the trees remains sequestered out of the atmosphere for long periods of time. Wood fiber can also be a renewable source of energy and replace fossil fuel energy. Wood products play a substantial role in helping forests to achieve their greatest contribution to mitigating greenhouse gases. Managed forests approach their maximum contribution to mitigating greenhouse gases when stocking levels support healthy trees that are resilient to wildfire and pests and the healthiest trees are grown to a mature condition before harvesting. Prior to European settlement, wildfire provided frequent adjustments to forest stocking levels and served to achieve more resilient forest conditions and an elevated carbon balance in California ecosystems. The recent history of fire management has resulting in unstable forest stocking conditions.

Timber harvest in the study area has been an important economic activity since the 1800s. Timber harvest levels today are controlled by strict forest practice rules that ensure harvest levels are sustainable. The State of California Board of Equalization[11] publishes annual timber harvest records by county that have been reported for timber harvest tax purposes. Figure 16 shows harvest levels in 1994 and more recent harvest levels from 2012 to 2016. Forest practice rules were modified in 1994 requiring an analysis of sustainability to ensure harvest levels could be sustained. Additionally, the listing of the Northern Spotted Owl as an endangered species affected timber harvest. Harvest levels have been substantially reduced but are steady and perhaps slowly increasing as forest inventories recover from decades of harvest that resulted in declining inventories.

Figure 16. Timber volume harvested by county in 1994 and consecutive years from 2012 to 2016.

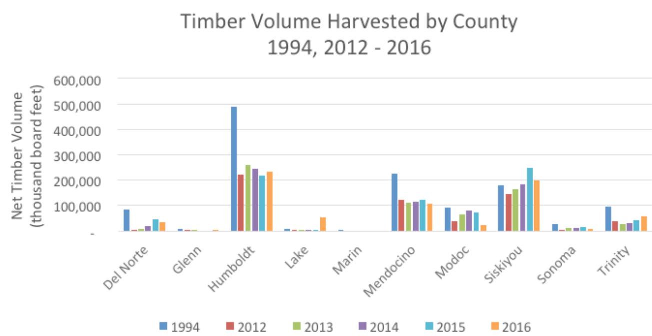
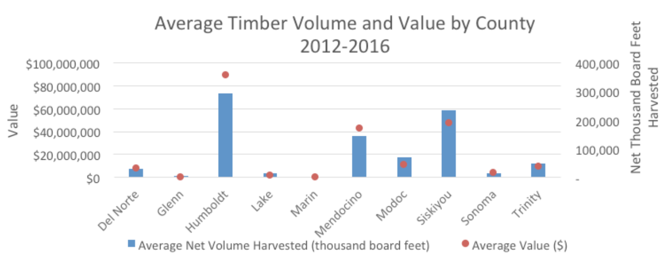


Figure 17 displays the average timber harvest and average value from 2012 to 2016 for each county in the study area. Timber harvest continues to be an important economic activity in the region.

Figure 17. Average timber volume harvested and value by counties included in the study area from 2012 to 2016.



When trees are harvested, CO_2-e may remain sequestered for long periods of time in harvested wood products and in landfills before they decompose and release the carbon stored in them to the atmosphere. The harvest volume, reported in board feet log volume must undergo several conversions to estimate the amount of carbon sequestered over a 100-year period in both harvested wood products and in landfills.

The data conversions required to estimate the CO_2-e sequestered in long-term wood products are shown in Table 11.

Table 11. Data conversions used to convert harvested logs into estimated CO_2-e sequestered.

Data Unit In		Conversion		Data Unit Out
Log Volume in Thousand Board Feet (Scribner Long Volume)	*	145	=	Log Volume in Cubic Feet
Log Volume in Cubic Feet	*	.0283	=	Log Volume in Cubic Meters
Log Volume in Cubic Meters	*	.675	=	Sawtimber in Cubic Meters. Conversion is a measure of mill efficiency.
Sawtimber in Cubic Meters	*	.3990	=	Sawtimber biomass. Conversion is the specific gravity in softwoods.
Sawtimber biomass.	*	.5	=	Sawtimber carbon
Sawtimber carbon	*	3.67	=	Sawtimber CO2-e
Sawtimber CO2-e	*	.76	=	Sawtimber remaining long-term (100 years) in wood products and/or in landfill.
All conversion units based on guidance from Climate Action Reserve from Harvested Wood Products Calculation Worksheet guidance.				

* (http://www.climateactionreserve.org/how/protocols/forest/)

The average timber harvest in the study area has averaged 850,637 thousand board feet a year over the timeframe from 2012 to 2016. This harvest amount represents 1,211,067 tonnes of CO_2e in sequestered wood products and landfill on an annual basis. This value is expected to increase as harvest volumes slowly increase in the future as forest inventories recover increase in inventory.

Enhancing resiliency of forests to wildfire and pests is generally achieved by removing biomass that historically and naturally was removed by more frequent wildfire. Investments in fuel reduction help to ward off large scale losses of biomass from wildfire. The material removed can be used to produce energy while displacing energy production from fossil fuels and can be used as feedstock for innovative wood products, such as cross laminated timber, which will increase the proportion of carbon in long-lived wood products.

OVERALL SUMMARY

The methodological approach is based on a blend of remotely sensed data and sampling processes. LANDFIRE was the basis of the remotely sensed data. Landfire vegetation classification accuracy is relatively low (Gonzalez et al, 2015). In addition, updates to LANDFIRE data only reflect growth in vegetation if the growth is substantial enough to modify the height or density class

11 http://www.boe.ca.gov/proptaxes/timbertax.htm

to a level that contains a higher biomass estimate. In other words, the biomass estimates are not continuous due to the step nature of height and density variables.

With increasing reliance on data resources like Landfire, it would seem likely that the accuracy of vegetation will improve and solutions will be derived to managing biomass estimates in between ground-based re-measurements. Obvious advantages of using Landfire is that it is updated on a two-year cycle, available across the United States, and free to users.

Future alternatives to Landfire data may include LIDAR and custom vegetation classifications using Landsat imagery (or other). LIDAR has been used to improve accuracies of height and density data which are important variables in assessing biomass, but would require other data sources since alone it cannot stratify vegetation composition into vegetation communities. Additionally, LIDAR is currently an expensive undertaking and not likely to be repeated at the same frequency as Landfire is. Custom classifications may improve the accuracy of the vegetation classification to at least the broad vegetation class (forest, shrubs, grasslands, etc.), but may lack some of the 'color' provided by Landfire that resolves vegetation to plant communities, height, and density.

Gonzalez (2015) includes an accuracy assessment for the estimates of standing aboveground biomass for the entire state. Standard errors for biomass estimates are more than 25% of the mean at the 95% confidence interval for the state. Estimates that tier off of the statewide data, such as this study that is looking at a narrow window of the statewide data, would certainly have even higher standard errors. Nor are we aware of an accuracy assessment for the landcover stratification. It appears to be reasonable for this type of assessment in terms of meeting general landcover designations, particularly for forest areas which are the most important carbon pool within the study area.

Similarly, soil carbon is based on a broad stratification effort with few sample points. LANDFIRE landcover typing is a national effort and has been found to be a useful tool, particularly for estimating the potential for wildfire events. Data outputs provided at a 30-meter resolution which provides a reasonable basis for strategic planning.

APPENDIX A. CLASSIFICATION OF LANDFIRE EVTS.

The base unit of landcover definition in ARB's database is the LANDFIRE 'EVT', which is a landcover/vegetation community class, the LANDFIRE 'EVC', which is a density estimate of the landcover class, and the LANDFIRE 'EVH', which is a height estimate of the landcover class, all of which are described on the LANDFIRE website[12]. These attributes are assigned to each 30-meter pixel in the nation-wide raster. The following tables demonstrate the approach this study took to placing the EVTs only (the table doesn't show the EVCs and EVHs) within Broader Classes. The Landcover Class and Landcover Subclass were developed for this effort. The IPCC descriptions were developed by Saah (2014) and are shown in this appendix for comparison.

Carbon comparisons can be made for each EVT, EVC, and EVH, if desired. There are 3,080 permutations of LANDFIRE EVTs, EVCs, and EVHs in the database for above-ground carbon stocking, and more if soil carbon is included. There are 44 permutations of EVCs and EVHs for the California Coastal Redwood Forest EVT alone. They vary in carbon densities from 3,938 tonnes of CO_2-e/hectare (above-ground) for an EVH > 50 meters and an EVC 90 – 100% to 251 tonnes of CO_2-e/hectare (above-ground) for an EVH of 0 – 10 meters and an EVC of 10 – 20%. Only the EVTs are shown below in Tables A1 (Barren, Orchard, Row Crop, Vineyard, and Wetlands), A2 (Grasslands and Shrublands), A3 (Coniferous Forests), A4 (Woodland Forests), and A5 (EVTs associated with Urban Areas).

Table A1. EVTs associated with Barren, Orchard, and Row Crop, Vineyard, and Wetland Landcover Classes.

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Barren	Barren	Other land	Barren
			Inter-Mountain Basins Sparsely Vegetated Systems
			Mediterranean California Sparsely Vegetated Systems
			North Pacific Sparsely Vegetated Systems
			Quarries-Strip Mines-Gravel Pits
			Rocky Mountain Alpine/Montane Sparsely Vegetated Systems
	Roads	Barren	Developed-Roads
	Snow	Other land	Snow-Ice
	Water	Water	Open Water
Orchard	Orchard	Cropland	Western Cool Temperate Orchard
			Western Warm Temperate Orchard
Row Crop	Agroforestry	Cropland	Western Cool Temperate Undeveloped Ruderal Deciduous Forest
			Western Cool Temperate Undeveloped Ruderal Evergreen Forest
			Western Cool Temperate Undeveloped Ruderal Mixed Forest
			Western Warm Temperate Developed Ruderal Deciduous Forest
			Western Warm Temperate Developed Ruderal Evergreen Forest
			Western Warm Temperate Developed Ruderal Mixed Forest
Row Crop	Row Crop	Cropland	Western Cool Temperate Close Grown Crop
			Western Cool Temperate Fallow/Idle Cropland
			Western Cool Temperate Row Crop
			Western Cool Temperate Row Crop - Close Grown Crop
			Western Warm Temperate Close Grown Crop
			Western Warm Temperate Fallow/Idle Cropland
			Western Warm Temperate Row Crop
			Western Warm Temperate Row Crop - Close Grown Crop
Vineyard	Vineyard	Cropland	Cropscape Vineyards 2012
			Western Cool Temperate Vineyard
			Western Warm Temperate Vineyard
Wetland	Wetland	Forest land	North Pacific Swamp Systems

12 https://www.Landfire.gov/vegetation.php

Table A2. EVTs associated with Grassland and Shrubland EVTs.

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Grassland	Grassland	Cropland	Western Cool Temperate Pasture and Hayland
			Western Cool Temperate Wheat
			Western Warm Temperate Pasture and Hayland
			Western Warm Temperate Wheat
	Grassland	Grassland	California Annual Grassland
			California Mesic Serpentine Grassland
			California Northern Coastal Grassland
			Inter-Mountain Basins Semi-Desert Grassland
			Introduced Upland Vegetation-Annual Grassland
			Introduced Upland Vegetation-Perennial Grassland and Forbland
			Mediterranean California Subalpine Meadow
			North Pacific Alpine and Subalpine Dry Grassland
			North Pacific Montane Grassland
			Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland
			Pacific Coastal Marsh Systems
			Rocky Mountain Subalpine-Montane Mesic Meadow
	Ruderal Grassland	Cropland	Western Cool Temperate Undeveloped Ruderal Grassland
			Western Warm Temperate Developed Ruderal Grassland
		Other land	Western Warm Temperate Undeveloped Ruderal Grassland
		Settlements	Western Cool Temperate Developed Ruderal Grassland
Shrubland	Ruderal Shrubland	Other land	Western Warm Temperate Undeveloped Ruderal Shrubland
Shrubland	Shrubland	Cropland	Western Cool Temperate Undeveloped Ruderal Shrubland
			Western Warm Temperate Developed Ruderal Shrubland
Shrubland	Shrubland	Forest land	Artemisia tridentata ssp. vaseyana Shrubland Alliance
			California Mesic Chaparral
			California Xeric Serpentine Chaparral
			Columbia Plateau Low Sagebrush Steppe
			Columbia Plateau Steppe and Grassland
			Great Basin Semi-Desert Chaparral
			Inter-Mountain Basins Big Sagebrush Shrubland
			Inter-Mountain Basins Big Sagebrush Steppe
			Inter-Mountain Basins Greasewood Flat
			Inter-Mountain Basins Mixed Salt Desert Scrub
			Inter-Mountain Basins Montane Riparian Shrubland
			Inter-Mountain Basins Montane Sagebrush Steppe
			Klamath-Siskiyou Xeromorphic Serpentine Savanna and Chaparral
			North Pacific Avalanche Chute Shrubland
			North Pacific Dry and Mesic Alpine Dwarf-Shrubland or Fell-field or Meadow
			North Pacific Montane Shrubland
			Northern and Central California Dry-Mesic Chaparral
			Northern California Coastal Scrub
			Northern Rocky Mountain Montane-Foothill Deciduous Shrubland

Table A3. EVTs associated with Coniferous and other Forest type EVTs.

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Forest	Coniferous Forest	Forest land	California Coastal Redwood Forest
			California Lower Montane Foothill Pine Woodland and Savanna
			California Montane Jeffrey Pine(-Ponderosa Pine) Woodland
			Coastal Douglas-fir Woodland
			East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
			East Cascades Oak - Ponderosa Pine Forest and Woodland
			East Cascades Ponderosa Pine Forest and Woodland
			Klamath-Siskiyou Lower Montane Serpentine Mixed Conifer Woodland
			Klamath-Siskiyou Upper Montane Serpentine Mixed Conifer Woodland
			Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
			Mediterranean California Lower Montane Conifer Forest and Woodland
			Mediterranean California Mesic Mixed Conifer Forest and Woodland
			Mediterranean California Mixed Evergreen Forest
			Mediterranean California Red Fir Forest
			Mediterranean California Subalpine Woodland
			North Pacific Dry Douglas-fir(-Madrone) Forest and Woodland
			North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest
			North Pacific Hypermaritime Seasonal Sitka Spruce Forest
			North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
			North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest
			North Pacific Mountain Hemlock Forest
			North Pacific Wooded Volcanic Flowage
			Northern California Mesic Subalpine Woodland
			Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
			Northern Rocky Mountain Foothill Conifer Wooded Steppe
			Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
			Pinus sabiniana Woodland Alliance
			Pseudotsuga menziesii Giant Forest Alliance
Forest	Juniper Woodland	Forest land	Columbia Plateau Western Juniper Woodland and Savanna
			Great Basin Pinyon-Juniper Woodland
			Juniperus occidentalis Wooded Herbaceous Alliance
			Juniperus occidentalis Woodland Alliance
Forest	Ruderal Deciduous Forest	Other land	Western Warm Temperate Undeveloped Ruderal Deciduous Forest
Forest	Ruderal Evergreen Forest	Other land	Western Warm Temperate Undeveloped Ruderal Evergreen Forest
Forest	Ruderal Mixed Forest	Other land	Western Warm Temperate Undeveloped Ruderal Mixed Forest

Table A4. EVTs associated with Woodland EVTs.

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Forest	Woodlands	Forest land	California Coastal Closed-Cone Conifer Forest and Woodland
			California Coastal Live Oak Woodland and Savanna
			California Lower Montane Blue Oak Forest and Woodland
			California Lower Montane Blue Oak-Foothill Pine Forest and Woodland
			California Montane Riparian Systems
			California Montane Woodland and Chaparral
			Douglas-fir - Oregon White Oak Woodland
			East Cascades Oak Forest and Woodland
			Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland
			Inter-Mountain Basins Montane Riparian Forest and Woodland
			Mediterranean California Lower Montane Black Oak - Conifer Forest and Woodland
			Mediterranean California Lower Montane Black Oak Forest and Woodland
			Mediterranean California Mixed Oak Woodland
			North Pacific Broadleaf Landslide Forest and Shrubland
			North Pacific Lowland Riparian Forest and Shrubland
			North Pacific Montane Riparian Woodland and Shrubland
			North Pacific Oak Woodland
			Oregon White Oak Woodland
			Quercus garryana Woodland Alliance
			Rocky Mountain Aspen Forest and Woodland
			Rocky Mountain Poor-Site Lodgepole Pine Forest
			Rocky Mountain Subalpine Mesic-Wet Spruce-Fir Forest and Woodland
			Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland
			Sierran-Intermontane Desert Western White Pine-White Fir Woodland

Table A5. EVTs associated with Urban EVTs (1 of 2).

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Urban Urban	Agroforestry	Cropland	Urban_Western Warm Temperate Developed Ruderal Mixed Forest
	Barren	Other land	Urban_Barren
			Urban_Mediterranean California Sparsely Vegetated Systems
			Urban_North Pacific Sparsely Vegetated Systems
			Urban_Quarries-Strip Mines-Gravel Pits
	Coniferous Forest	Forest land	Urban_California Coastal Redwood Forest
			Urban_California Lower Montane Foothill Pine Woodland and Savanna
			Urban_California Montane Jeffrey Pine(-Ponderosa Pine) Woodland
			Urban_Coastal Douglas-fir Woodland
			Urban_East Cascades Ponderosa Pine Forest and Woodland
			Urban_Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
			Urban_Mediterranean California Mesic Mixed Conifer Forest and Woodland
			Urban_Mediterranean California Mixed Evergreen Forest
			Urban_Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
			Urban_Pinus sabiniana Woodland Alliance
	Grassland	Cropland	Urban_Western Cool Temperate Pasture and Hayland
			Urban_Western Cool Temperate Wheat
			Urban_Western Warm Temperate Wheat
	Grassland	Grassland	Urban_California Annual Grassland
			Urban_Introduced Upland Vegetation-Annual Grassland
			Urban_Introduced Upland Vegetation-Perennial Grassland and Forbland
			Urban_North Pacific Montane Grassland
			Urban_Pacific Coastal Marsh Systems
			Urban_Rocky Mountain Subalpine-Montane Mesic Meadow
	Juniper Woodland	Forest land	Urban_Juniperus occidentalis Wooded Herbaceous Alliance
	Low Intensity	Settlements	Developed-Low Intensity
			Urban_Developed-Low Intensity
	Other Urban Other Urban Forest	Settlements Settlements	Developed-High Intensity
			Developed-Medium Intensity
			Urban_Developed-High Intensity
			Urban_Developed-Medium Intensity
			Urban_Western Cool Temperate Developed Ruderal Deciduous Forest
			Urban_Western Cool Temperate Developed Ruderal Evergreen Forest
			Urban_Western Cool Temperate Developed Ruderal Mixed Forest
			Urban_Western Cool Temperate Urban Deciduous Forest
			Urban_Western Cool Temperate Urban Evergreen Forest
			Urban_Western Cool Temperate Urban Mixed Forest
			Urban_Western Warm Temperate Urban Deciduous Forest
			Urban_Western Warm Temperate Urban Evergreen Forest
			Urban_Western Warm Temperate Urban Mixed Forest
			Western Cool Temperate Developed Ruderal Deciduous Forest
			Western Cool Temperate Developed Ruderal Evergreen Forest
			Western Cool Temperate Developed Ruderal Mixed Forest
			Western Cool Temperate Urban Deciduous Forest
			Western Cool Temperate Urban Evergreen Forest
			Western Cool Temperate Urban Mixed Forest
			Western Warm Temperate Urban Deciduous Forest
			Western Warm Temperate Urban Evergreen Forest
			Western Warm Temperate Urban Mixed Forest

Table A6. EVTs associated with Urban EVTs (2 of 2).

Landcover Class	Landcover Subclass	IPCC Description	LANDFIRE Description (EVTs)
Urban	Other Urban Grassland	Settlements	Urban_Western Cool Temperate Urban Herbaceous
			Urban_Western Warm Temperate Urban Herbaceous
			Western Cool Temperate Urban Herbaceous
			Western Warm Temperate Urban Herbaceous
	Other Urban Shrubland	Settlements	Urban_Western Cool Temperate Developed Ruderal Shrubland
			Urban_Western Cool Temperate Urban Shrubland
			Urban_Western Warm Temperate Urban Shrubland
			Western Cool Temperate Developed Ruderal Shrubland
			Western Cool Temperate Urban Shrubland
			Western Warm Temperate Urban Shrubland
	Roads	Barren	Urban_Developed-Roads
	Row Crop	Cropland	Urban_Western Cool Temperate Close Grown Crop
			Urban_Western Cool Temperate Fallow/Idle Cropland
			Urban_Western Warm Temperate Close Grown Crop
			Urban_Western Warm Temperate Fallow/Idle Cropland
	Ruderal Grassland	Cropland	Urban_Western Warm Temperate Developed Ruderal Grassland
	Shrubland	Settlements	Urban_Western Cool Temperate Developed Ruderal Grassland
	Shrubland	Cropland	Urban_Western Warm Temperate Developed Ruderal Shrubland
	Shrubland	Forest land	Urban_California Mesic Chaparral
			Urban_California Montane Woodland and Chaparral
			Urban_Great Basin Semi-Desert Chaparral
			Urban_Klamath-Siskiyou Xeromorphic Serpentine Savanna and Chaparral
			Urban_North Pacific Dry and Mesic Alpine Dwarf-Shrubland or Fell-field or Meadow
			Urban_North Pacific Montane Shrubland
			Urban_Northern and Central California Dry-Mesic Chaparral
			Urban_Northern California Coastal Scrub
	Vineyard	Cropland	Urban_Cropscape Vineyards 2012
			Urban_Western Warm Temperate Vineyard
	Water	Water	Urban_Open Water
	Woodlands	Forest land	Urban_California Coastal Closed-Cone Conifer Forest and Woodland
			Urban_California Coastal Live Oak Woodland and Savanna
			Urban_California Lower Montane Blue Oak Forest and Woodland
			Urban_California Lower Montane Blue Oak-Foothill Pine Forest and Woodland
			Urban_California Montane Riparian Systems
			Urban_Inter-Mountain Basins Montane Riparian Forest and Woodland
			Urban_Mediterranean California Lower Montane Black Oak — Conifer Forest and Woodland
			Urban_Mediterranean California Mixed Oak Woodland
			Urban_North Pacific Montane Riparian Woodland and Shrubland
			Urban_North Pacific Oak Woodland
			Urban_Oregon White Oak Woodland
			Urban_Quercus garryana Woodland Alliance