County of Sonoma

Carbon Inventory and Sequestration Potential Study

October 2023

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EXECUTIVE SUMMARY

Climate change has harmful, sometimes catastrophic effects on public health, natural resources, infrastructure, and emergency response. Sonoma County has already felt the effects of climate change at the local level, through lives and homes tragically lost to wildfire including the Nuns, and Pocket Fires and Kincade fires, which burned 143,388 acres of Sonoma County between 2017 and 2019 (CAL FIRE, 2017, 2019). The LNU Lightning Complex, and Glass Fires of 2020 also burned significant acreage across Sonoma County. Natural and working lands have been recognized as a powerful tool to address climate change, allowing the County of Sonoma to make progress towards its greenhouse gas (GHG) reduction goals, while increasing resiliency to future climate impacts. Natural and working lands, which include the iconic redwood forests, oak woodlands, vineyards, and pasturelands found across Sonoma County, can be a powerful engine for mitigating climate change and increasing resilience to climate impacts through climate smart land management practices (climate smart practices).

The purpose of this Carbon Inventory and Sequestration Potential Study (Study) is to establish the first detailed quantitative estimate of Sonoma County's historical and existing carbon stocks and changes over time. This is a critical first step in meeting local, State, and national climate goals as it identifies baseline conditions, and methods for identifying changes in carbon stocks over time. It should be noted that new programs are being undertaken to assess carbon sequestration on working lands, which will be described further in ***Section 2 Regional Efforts***. The Study also assesses the potential impact of climate smart practices, and ultimately identifies a set of measures and actions for the County and key stakeholders to consider for implementation across Sonoma County's rich and varied landscapes.

HOW THIS STUDY ADVANCES SONOMA COUNTY'S CLIMATE GOALS

The County of Sonoma has developed specific goals to decrease net greenhouse gas (GHG) emissions and achieve carbon neutrality by 2030 through decarbonization and sequestration and develop policies to optimize carbon sequestration while minimizing the loss of natural carbon sinks. This direction comes from the County of Sonoma 5-year Strategic Plan, which was approved by the Board of Supervisors on March 2, 2021. This Study implements the County's 5-Year Strategic Plan by assessing the carbon sequestration potential of climate smart practices while considering the climate change impact on carbon stocks. There are numerous policies and plans developed by the County of Sonoma and other local agencies to address climate smart practices on natural and working lands.

- Sonoma County Board of Supervisors Climate Change Action Resolution (18-0166)
- Sonoma County 5-Year Strategic Plan 2021-2026 Climate Action and Resiliency: Goal 5
- Sonoma County General Plan
- Sonoma County Climate Resilient Lands Strategy
- Sonoma County Integrated Parks Plan
- Regional Parks Sonoma County Strategic Plan 2023-2025
- Sonoma County Ag + Open Space 2021 Vital Lands Initiative
- Sonoma County Ag + Open Space Healthy Lands and Healthy Economies
- Community Grazing Collaboratives
- Sonoma Water Climate Adaptation Plan
- Sonoma Climate Mobilization Strategy, Regional Climate Protection Authority
- Climate Action 2020 and Beyond, Regional Climate Protection Authority

This Study is intended to provide a starting point for further analysis informed by local climate smart practice planning and implementation activities. The County, along with many regional partners, has embarked on the Sonoma-Marin Ag and County Climate Coalition (SMACCC) project, funded by the USDA Climate Smart Commodities grant program. SMACCC project implementation and monitoring efforts within the Sonoma County will be led by the Gold Ridge Resource Conservation District and the Sonoma Resource Conservation District (RCDs). The RCDs will leverage their local expertise and ongoing relationships with the agricultural community to increase the pace and scale of carbon farm planning and climate smart practice implementation. Data gathered from these efforts will be used to refine the sequestration and co-benefits analysis, further localized climate smart agricultural planning, and evaluate realistic adoption targets for practices given the sequestration potential, logistics, costs, and numerous co-benefits associated with each practice. Future planning for climate smart practice implementation should incorporate RCD data based on local implementation activities as much as possible and be guided by the work of the SMACCC project. Additionally, future analysis could elaborate on how the land use categories utilized for the purposes of this Study equate to local zoning designations, to aid decision makers in incorporating these findings into general plan policies and goals.

WHAT IS CARBON SEQUESTRATION AND WHY IS IT IMPORTANT?

Carbon sequestration is the removal and storage of carbon from the atmosphere. This process occurs naturally through plant photosynthesis, where carbon is drawn from the atmosphere and into plants and soil. Both natural and working lands can be carbon sinks, where plants and soils take in more carbon than they release. Conserving these carbon sinks can help move the county closer to achieving the objectives of carbon neutrality, land conservation, and carbon sequestration (County of Sonoma, 2021). Carbon sequestration is not the only benefit of conserving, restoring, and strategically managing natural and working lands. Natural and working lands also provide numerous social, economic, and ecosystem benefits to wildlife and the wider community. In most cases, the co-benefits of climate smart practices (e.g., habitat creation and water quality) motivate implementation while carbon sequestration is an added benefit, not often quantified until recently. The focus of this Study is to consider the potential impacts of increasing the pace and scale of implementing climate smart practices that increase the overall health of natural and working lands, while providing additional, social, economic, and ecosystem benefits.

APPROACH

This Study includes land-based carbon inventories for 2013 and 2022. The land-based carbon inventories quantify the amount of carbon stored across different land cover classes, establishing a baseline to assess the existing carbon stock and sequestration potential of natural and working lands. This snapshot of existing carbon stock and sequestration by land cover class demonstrates what could be lost if carbon stocks across Sonoma County are not stabilized (e.g., if forests are lost to wildfire) or what could be built upon through optimizing climate smart land management practices. The land-based carbon inventory also allows for the modeling of future carbon sequestration potential and GHG reduction of different land-management activities, which can serve as the basis to inform selecting and prioritization of climate smart practices for County of Sonoma.

This land-based carbon inventory is calculated by first assessing the type of land cover classes across Sonoma County by acre, and then by quantifying the amount of carbon stored in the different land cover classes. Inventories provide a snapshot of the carbon stock in a region's land-based ecosystems at a given moment in time. Comparing land cover and carbon inventory values between years can help identify trends in land cover change and estimate increases or decreases in carbon stocks. Carbon stock assessments described in this Study account for land-cover based changes between years, and do not account for changes in land management practices. This analysis also includes a description of carbon stock by landownership, as implementing climate-smart solutions across public and private ownership will require different degrees of coordination, and different stakeholder-tailored strategies.

SONOMA COUNTY CARBON STOCK INVENTORIES

Sonoma County's diverse landscapes held approximately 117,593,161 MT CO_2e in 2013 and 105,365,590 MT CO_2e in 2022, providing critical co-benefits like healthy ecosystems and watersheds, recreation areas, and local food production. Carbon stocks and emission potential varies by land cover. For example, in croplands carbon stocks are relatively stable to fire risks because they are generally irrigated and heavily managed landscapes, while shrubland and forests may be more susceptible to losses from wildfire. Land conversion (e.g., development conversions of wildland or agricultural to other uses), can result in carbon stock losses. This Study captures carbon stock changes based on vegetation type, cover, and height. The results of the Sonoma County Carbon Inventories are provided in ***Table ES-1***. The sources, methodology, and further detail on this analysis are described in ***Section 3 Land Cover and Carbon Stock Analysis*** and ***Appendix B Sonoma County Land Cover, Carbon Stock, and Natural GHG Emissions Inventory Results Memorandum***.

Table ES-1. 2013 and 2022 Sonoma County Total Carbon Stock

Land Cover Class	2013 Total Carbon Stock (MT CO_2e)	2022 Total Carbon Stock (MT CO_2e)	Percent Change between 2013 and 2022 (MT CO_2e)
Barren	440,119	367,468	-17
Cultivated and Field Crops	100,577	101,027	0
Development	6,962,559	7,749,627	11
Forest	78,034,944	61,578,011	-21
Grassland/Herbaceous	18,109,720	17,988,852	-1
Open Water	675,920	1,303,822	93
Orchard	239,362	202,396	-15
Pasture and Hay	2,396,328	3,944,917	65
Shrub/Scrub	4,094,253	5,196,075	27
Vineyard	3,593,475	4,582,317	28
Wetland	2,945,905	2,354,039	-20
Total	**117,593,161**	**105,365,950**	**-10**

CLIMATE SMART PRACTICES TO INCREASE CARBON SEQUESTRATION

Evaluating carbon sequestration potential on the regional level helps us understand what climate smart practices could potentially achieve the greatest amount of carbon sequestration and work towards meeting climate goals. This Study estimated the following for each climate smart practice (see ***Table ES-2***):

- Estimated implementation acreage
- Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan
- Annual Carbon Sequestration – 100 Percent Adoption Scenario

For further discussion see ***Section 4 Climate Smart Practices and Analysis*** and for a full description of the methodology please refer to ***Appendix C Carbon Sequestration Analysis of Climate Smart Practices***.

Table ES-2. Estimated Implementation Acreages for All Climate Smart Practices

Climate Smart Practice	Estimated Implementation Acreage (AC)	Expected Practice Lifespan	Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan (MT CO_2e)	Annual Carbon Sequestration – 100 Percent Adoption Scenario (MT CO_2e)
NATURAL LANDS				
Forest				
Forest Slash Treatment (CPS 384)	414,591	NA	NA	NA
Fuel Reduction	399,044	20	7,980,870	399,044
Improved Forest Management Thinning from Below	15,548	50	1,399,284	27,986
Riparian Restoration	970	45	296,602	6,591
Grasslands				
Native Grassland Restoration	132,077	50	3,957,357	79,147
Oak Woodland Restoration	11,889	50	861,953	17,239
Riparian Restoration	339	45	103,658	2,304
URBAN FOREST				
Development				
Urban Forestry	5,266	50	35,056,040	701,121

Climate Smart Practice	Estimated Implementation Acreage (AC)	Expected Practice Lifespan	Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan (MT CO_2e)	Annual Carbon Sequestration – 100 Percent Adoption Scenario (MT CO_2e)
URBAN FARMS				
Cultivated and Field Crops Orchards and Vineyards				
Biochar Application (CPS 336)	59	NA	NA	NA
Cultivated and Field Crops				
Compost Application and Nutrient Management (CPS 590)	7.1	6	87	14
Conservation Crop Rotation (CPS 328)	24.0	1	5	5
Cover Cropping (CPS 340)	5.3	1	2	2
Field Border (CPS 386)	6.7	20	165	8
Hedgerow Planting (CPS 422)	0.4	34	121	4
Mulching (CPS 484)	7.7	5	12	2
Residue and Tillage Management - No Till (CPS 329)	24.0	1	5	5
Residue and Tillage Management - Reduced Till (CPS 345)	24.0	1	3	3
Windbreak/Shelterbelt Establishment (CPS 380)	1.6	80	1,048	13
Orchard and Vineyard				
Compost Application and Nutrient Management (CPS 590)	51.8	6	482	80
Cover Cropping (CPS 340)	38.8	1	64	64
Hedgerow Planting (CPS 422)	3.1	34	864	25
Mulching (CPS 484)	56.1	5	95	19
Residue and Tillage Management - No Till (CPS 329)	114.4	1	40	40
Residue and Tillage Management - Reduced Till (CPS 345)	114.4	1	14	14
Windbreak/Shelterbelt Establishment (CPS 380)	11.4	80	7,493	94

Climate Smart Practice	Estimated Implementation Acreage (AC)	Expected Practice Lifespan	Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan (MT CO_2e)	Annual Carbon Sequestration – 100 Percent Adoption Scenario (MT CO_2e)
WORKING LANDS				
All Agricultural Land Covers				
Riparian Forest Buffer (CPS 391)	4,503	45	1,835,873	40,797
Riparian Herbaceous Cover (CPS 390)	4,503	10	9,456	946
Cultivated and Field Crops				
Alley Cropping (CPS 311)	1,210	15	31,581	2,105
Biochar Application (CPS 336)	849	NA	NA	NA
Compost Application (CPS 808) - Compost C/N </= 11, 3 tons per acre	849	6	10,545	1,758
Compost Application (CPS 808) - Compost C/N > 11, 6 tons per acre	849	6	22,109	3,685
Compost Application (CPS 808) and Nutrient Management (CPS 590)	849	6	10,443	1,741
Conservation Cover (CPS 327)	61	1	38	38
Conservation Crop Rotation (CPS 328)	1,210	1	266	266
Cover Cropping (CPS 340)	849	1	340	340
Field Border (CPS 386)	109	20	2,679	134
Filter Strip (CPS 393)	17	10	215	21
Hedgerow Planting (CPS 422)	23	34	6,539	192
Mulching (CPS 484)	551	5	882	176
Nutrient Management (CPS 590)	849	1	-17	-17
Pasture and Hay Planting (CPS 512)	121	5	738	148
Residue and Tillage Management - No Till (CPS 329)	1,210	1	266	266
Residue And Tillage Management - Reduced Till (CPS 345)	1,210	1	145	145
Windbreak/Shelterbelt Establishment (CPS 380)	33	80	21,899	274
Orchard				
Biochar Application (CPS 336)	2,313	NA	NA	NA
Compost Application (CPS 808)	2,264	6	21,056	3,509

Climate Smart Practice	Estimated Implementation Acreage (AC)	Expected Practice Lifespan	Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan (MT CO_2e)	Annual Carbon Sequestration – 100 Percent Adoption Scenario (MT CO_2e)
Compost Application (CPS 808) and Nutrient Management (CPS 590)	2,264	6	21,056	3,509
Cover Cropping (CPS 340)	2,313	1	3,793	3,793
Filter Strip (CPS 393)	300	10	1,801	180
Hedgerow Planting (CPS 422)	86	34	23,862	702
Mulching (CPS 484)	2,267	5	3,853	771
Nutrient Management (CPS 590)	2,264	1	0	0
Residue and Tillage Management - No Till (CPS 329)	1,861	1	651	651
Residue and Tillage Management - Reduced Till (CPS 345)	1,861	1	223	223
Whole Orchard Recycling (CPS 808)	3,101	20	2,481	124
Windbreak/Shelterbelt Establishment (CPS 380)	83	80	54,721	684
Vineyard				
Biochar Application (CPS 336)	58,233	NA	NA	NA
Compost Application (CPS 808)	57,007	6	530,165	88,361
Compost Application (CPS 808) and Nutrient Management (CPS 590)	57,007	6	530,165	88,361
Cover Cropping (CPS 340)	58,233	1	95,502	95,502
Filter Strip (CPS 393)	300	10	1,800	180
Hedgerow Planting (CPS 422)	2,155	34	600,824	17,671
Mulching (CPS 484)	57,069	5	97,018	19,404
Nutrient Management (CPS 590)	57,007	1	0	0
Residue and Tillage Management - No Till (CPS 329)	54,657	1	19,130	19,130
Residue and Tillage Management - Reduced Till (CPS 345)	54,657	1	6,559	6,559
Windbreak/Shelterbelt Establishment (CPS 380)	2,100	80	1,377,849	17,223

Climate Smart Practice	Estimated Implementation Acreage (AC)	Expected Practice Lifespan	Estimated Carbon Sequestration for 100 Percent Adoption Over Practice Lifespan (MT CO_2e)	Annual Carbon Sequestration – 100 Percent Adoption Scenario (MT CO_2e)
GRAZING LANDS				
Rangelands and Pasture				
Compost Application To Rangelands (CPS 808)	21,437	20	638,823	31,941
Rangelands				
Native Oak Restoration/Silvopasture (CPS 381)	51,655	50	3,460,885	69,218
Prescribed Grazing (CPS 528) (Rangelands)	142,371	10	128,134	12,813
Range Planting (CPS 550)	44,420	10	222,099	22,210
Riparian Forest Buffer (CPS 391)	1,400	45	570,780	12,684
Tree/Shrub Establishment (CPS 612)	2,847	20	1,075,755	53,788
Pasture				
Prescribed Grazing (CPS 528) (Pasture)	8,200	10	8,200	820

Note: NA = Not available. These are practices for which there is not a sequestration or emissions reduction coefficient available, yet are understood to increase carbon sequestration or reduce emissions, as well as provide other benefits, and for which we can estimate implementation acreages even though we cannot quantify the sequestration benefit estimate. Practices where the carbon sequestration benefits are not currently quantifiable are still recommended for inclusion in the suite of potential climate smart practices to be considered by the County.

MOVING FORWARD

Sonoma County can use the results of this analysis, along with stakeholder input, to inform climate smart practice implementation, and targets for implementation. Whichever climate smart practices are ultimately selected, monitoring and reporting are going to play an essential role in all practice implementation to ensure practice compliance, transparency, and verification of progress towards achievement of selected goals and targets.

Practices undertaken as part of the California Department of Food and Agriculture (CDFA) Healthy Soils Program or other grant programs supporting and funding climate smart agriculture will have monitoring and reporting requirements as mandated through those programs. Reporting requirements for any activity may include, but are not limited to, the following:

- Assessor's Parcel Numbers of parcels where activity is being implemented
- Map of activity area, including total acreage upon which activity is being implemented
- Date of activity initiation
- Anticipated duration of activity (max. based on duration of analysis above)
- Ongoing reporting throughout activity implementation

The County can leverage partnerships and technology to reduce the reporting burden for land managers implementing climate smart practices, and to monitor implementation progress.