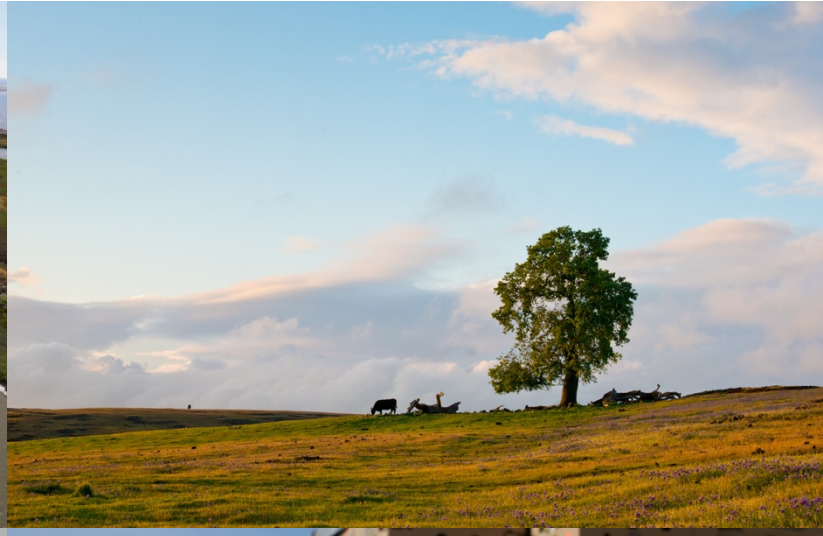
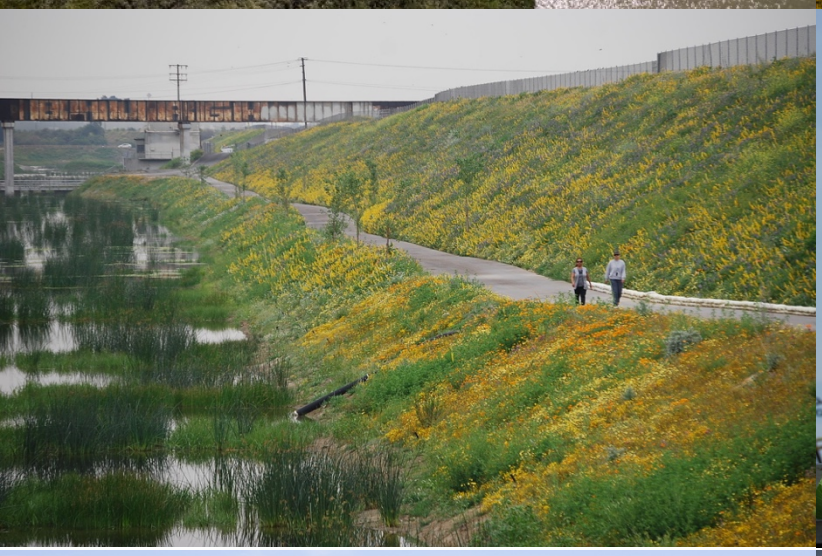

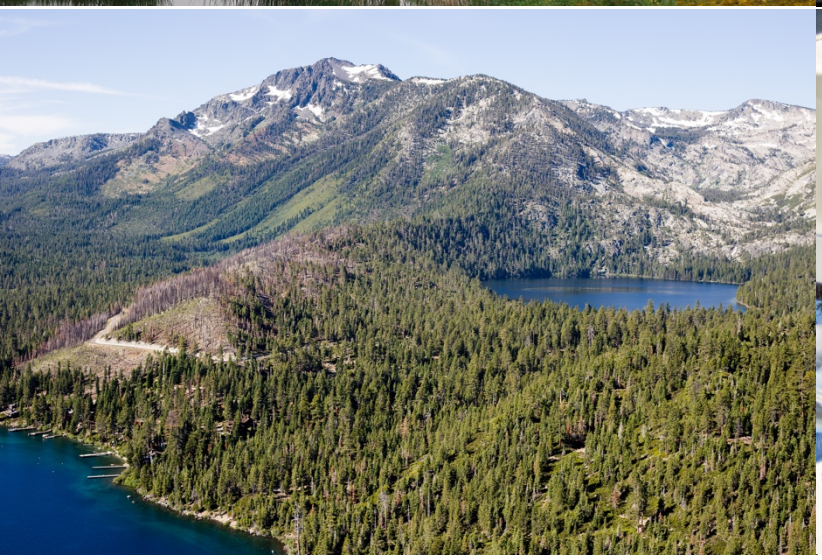

JANUARY 2019 DRAFT

CalEPA California Environmental Protection Agency

California Natural Resources Agency

cdfa California Department of Food & Agriculture

California Air Resources Board

California Strategic Growth Council

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Cover photos, clockwise from top left: 1) South Bay Salt Pond, *Cris Benton*; 2) Table Mountain, *Florence Low / California Department of Water Resources*; 3) Field workers in Monterey County, *John Chacon / California Department of Water Resources*; 4) California State Fair, *Florence Low / California Department of Water Resources*; 5) Tahoe after Emerald Fire, *Eric Prado*; 6) Dominguez Gap Wetlands, *San Gabriel & Lower Los Angeles Rivers and Mountains Conservancy*

EXECUTIVE SUMMARY

California's natural and working lands, and the multitude of benefits they provide, are changing and, in many areas, deteriorating or disappearing. These lands cover more than 90 percent of California and include rangeland, forests, woodlands, wetlands and coastal areas, grasslands, shrubland, farmland, riparian areas, and urban green space. They provide life-sustaining resources including clean air and water, food, and fiber. With their potential to sequester carbon, reduce greenhouse gas (GHG) emissions, and increase the capacity for California to withstand inevitable climate impacts, these lands are also a critical component of California's integrated climate change strategy. However, some sources, such as the California Air Resources Board's Natural and Working Lands Greenhouse Gas Inventory, show that California's natural and working lands are a net GHG source, losing more carbon than they are sequestering, with wildfire being the largest cause of carbon loss.[1]

To achieve the deep GHG reductions needed to avoid the most catastrophic impacts of climate change, the State must boldly and immediately increase its efforts to conserve, restore, and manage, natural and working lands. This 2030 Natural and Working Lands Climate Change Implementation Plan (Plan) poses an increase in State-led conservation, restoration, and management activities from two to five times above current levels, to achieve a level of effort commensurate with that invested in other sectors of California's climate change portfolio.

This Plan grew from years of agency coordination and stakeholder engagement. It advances deeper collaborations to render our lands a resilient carbon sink through adaptive, science-driven actions. With this Plan, the State is aiming to integrate climate and existing management objectives wherever possible, coordinating natural and working lands programs under a united approach that will move us toward our combined goal of maintaining a resilient carbon sink and improved air and water quality, water quantity, wildlife habitat, recreation, and other benefits. This Plan describes:

- The **need** to increase actions to mitigate climate change through improved conservation, restoration, and management of our natural and working lands;
- The **directives** to set a 2030 GHG reduction goal for natural and working lands and to develop an implementation plan;
- The **2030 pathway** for significantly increasing State-supported actions; and
- The **next steps** for a comprehensive approach to embedding California's natural and working lands within the State's climate strategy.

Our efforts must be intensified immediately because of the extended time horizons needed to achieve ecologically meaningful change. To make progress in achieving our long-term objective of maintaining resilient land-based carbon and ecosystems, the State needs to more

[1] California Air Resources Board. (2018) An Inventory of Ecosystem Carbon in California's Natural & Working Lands. https://www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm

than double the pace and scale of State-supported land activities by 2030 and beyond. This Plan sets goals for, at a minimum, increasing fivefold the rate of State-funded soil conservation practices, doubling the rate of State-funded forest management and restoration efforts, tripling the rate of State-funded oak woodland and riparian reforestation, and doubling the rate of State-funded wetland and seagrass restoration.

The conservation, restoration, and management activities described in this Plan are focused on State-supported efforts implemented through programs at the California Department of Food and Agriculture (CDFA), California Environmental Protection Agency (CalEPA), California Strategic Growth Council (SGC), and the California Natural Resources Agency (CNRA) and its boards, departments, and conservancies. Implementation will occur on State-owned lands or be funded with State dollars on private, tribal, federal, and other public lands.

The level of effort suggested in this Plan will require productive collaboration and work across jurisdictional boundaries. Success will also rely on engaging willing landowners and local, regional, and tribal stewards; forming new partnerships; advancing innovations in technology; and supporting bioresource markets. Intensifying efforts through multiple financial tools and investment sources and new, innovative approaches, in addition to augmenting established effective practices, will help the State achieve these goals. Success will require research, investment, and actions from agencies and landowners beyond the State's jurisdiction.

State agencies will strive to meet multiple objectives with actions that also address additional economic, environmental, and public health goals. By moving toward an integrated multi-benefit approach that considers carbon, other critical ecosystem services, biodiversity, sustainable communities, public health, and the economy, we can leverage efforts for maximum and sustained benefit.

Implementation of this Plan will begin immediately. Implementation will include a public process to learn through action, report progress, and estimate the full potential for natural and working lands to contribute to our climate goals, including carbon neutrality. Future updates of the Scoping Plan will reflect this pivotal role for natural and working lands to improve public health, contribute to climate goals, and sustain the many ecosystem benefits on which Californians and communities worldwide depend.

I. INTRODUCTION

A. Need for Action

California's natural and working lands are places – forests, grasslands, shrublands, woodlands, rangelands, farmland, wetlands, and the green spaces in urban and built environments (Figure 1). They are home to nearly 40 million Californians, as well as the largest and most diverse sources of food and fiber production, producing over half the nation's fruits, nuts and vegetables. Natural and working lands are the foundation of the State's water supply, contributing water for agricultural crops, quality drinking water to residents throughout California, and supplying over 14 percent of the State's energy use through hydropower.

Figure 1. California's natural and working lands—including forests, grasslands, rangelands, farmland, wetlands and coastal areas, and the green spaces in urban and built environments—make up more than 90 percent of the State's land area and provide a range of environmental, social, health, and economic benefits statewide.

Additionally, most of these places are within California's Floristic Province, which is one of only 33 global biodiversity hotspots. These places provide important and significant environmental and public health benefits to the State, supporting clean air, wildlife and pollinator habitat, recreation and exercise, sustainable communities, tribal communities and practices, and strong economies. They are also a key component in the State's climate strategy. Keeping these lands and waters intact and at high levels of ecological function, including resilient carbon stocks, is critical for the well-being and security of Californians though 2030 and beyond.

Our natural and working lands are often the first to experience the impacts of climate change. Historically, they have helped regulate our climate by removing carbon dioxide from the atmosphere and storing it as carbon in soil and wood. However, it is increasingly clear that California's natural and working lands are deteriorating and that the critical ecosystem services they provide, including their ability to sequester carbon from the atmosphere, are at risk. In fact, some current data show that California's natural and working lands are a net greenhouse gas (GHG) source, losing more carbon than they sequester.[2]

[2] California Air Resources Board. (2018) An Inventory of Ecosystem Carbon in California's Natural & Working Lands: https://www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm

We expect to continue to lose carbon from the land as a result of extreme events exacerbated by climate change, drought, wildfire, land subsidence, development, and other disturbances. Actions to protect, restore, and sustainably manage our lands can greatly accelerate our progress to mitigate climate change and our ability to adapt to its impacts. Conversely, inaction will result in falling short of the deep reductions needed to avoid the most catastrophic climate impacts.

While land protection and appropriate management have been policy priorities for decades, this Plan recognizes and elevates the importance of formally addressing natural and working lands in California's climate strategy. We need a concerted and ambitious effort to protect carbon stocks, increase carbon sequestration, and reduce GHG emissions on our lands to change their current trajectory, moving California's lands toward a resilient carbon sink. Such an ambitious goal for natural and working lands requires effort commensurate with the effort exerted in all other sectors that contribute to meeting California's ambitious climate goals.

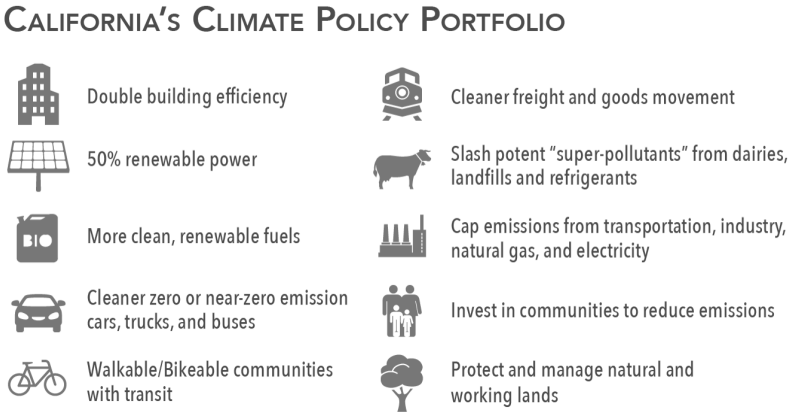
The extended time horizon needed to achieve ecologically meaningful change on our lands means we must intensify efforts immediately and adjust strategies as we learn. As such, this Plan identifies the scope and scale of a suite of State-supported land management, restoration, and conservation activities that protect carbon stocks, increase carbon sequestration, and reduce GHG emissions on wildland and urban forests, farmlands and ranchlands, oak woodlands, shrublands, grasslands, wetlands, and subtidal habitat. Through implementation and monitoring of this suite of actions, we will be able to better calibrate the scope and magnitude of long-term effort needed to ensure our land base is healthy and resilient and that we are able to maintain and increase the multiple-benefits they provide, even in the face of a changing climate.

The urgent need to address the health and resiliency of our natural and working lands for climate benefits comes with real opportunity to meet multiple objectives across sectors with actions that support additional economic, environmental, and public health goals. For decades, State programs for land management, restoration, and conservation, have been implemented primarily to meet traditional resource management objectives. Other more recent programs have had the primary objective of climate mitigation or adaptation. These separate objectives are not mutually exclusive. In most cases, they are complementary and synergistic.

With this Plan, the State is aiming to integrate management objectives wherever possible, coordinating all natural and working lands programs under a united approach that will move us toward our combined goals of maintaining a resilient carbon sink and improved air and water quality, water quantity, wildlife habitat, recreation, and other benefits. By advancing an integrated multi-benefit approach that considers carbon storage and other critical ecosystem services, biodiversity, public health, and the economy, we can leverage efforts for maximum and sustained benefit.

B. Directives

In his 2015 State of the State address, Governor Brown established 2030 targets for GHG emission reductions and called for policies and actions to reduce GHG emissions from natural and working lands, including forests, rangelands, farmlands, wetlands, and soils. In 2016, these policy objectives were codified through passage of Senate Bill (SB) 32 (Pavley, Chapter 249, Statutes of 2016) and SB 1386 (Wolk, Chapter 545, Statutes of 2016). SB 32 commits California to reducing emissions 40 percent below 1990 levels by 2030, and SB 1386 identifies the protection and management of natural and working lands as a key strategy towards meeting this ambitious GHG emissions reduction goal. Specifically, SB 1386 directs State agencies to consider the carbon sequestration potential of natural and working lands "when revising, adopting, or establishing policies, regulations, expenditures, or grant criteria related to [their] protection and management." The Governor further supported these activities with Executive Order B-52-18, which calls for improved management of the State's forests, and Executive Order B-54-18, which calls for actions to protect the State's biodiversity from current and future challenges of climate change.



Consistent with this direction, California's 2017 Climate Change Scoping Plan restates that reducing GHG emissions from and increasing sequestration on natural and working lands is crucial in the State's long-term climate change strategy. It outlines climate objectives for natural and working lands: to maintain them as a resilient carbon sink (i.e., net zero or even negative GHG emissions) and set a preliminary goal to reduce GHG emissions from them by at least 15 – 20 million metric tons of carbon dioxide equivalents (MMT CO_2e) by 2030. The California Air Resources Board (CARB) Resolution 17-46 directs the CARB Executive Officer to work with CNRA, CDFA, CalEPA, and other agencies to reevaluate the 15 – 20 MMT CO_2e 2030 goal; determine if the goal should be adjusted in light of ongoing analyses to estimate the GHG mitigation potential of natural and working lands; and to develop this Natural and Working Lands Climate Change Implementation Plan.

In September 2018, Governor Brown signed Executive Order B-55-18, which establishes a goal for the State to achieve carbon neutrality by 2045 and maintain net-negative emissions after that. In October 2018, the Intergovernmental Panel on Climate Change released a report outlining the dangers to the economy and society if temperatures increase more than 1.5 degrees Celsius above pre-industrial levels. The report suggests that to keep temperature rise

below 1.5 degrees Celsius, we must achieve global carbon neutrality in the 2040 to 2045 timeframe.[3] While the State is still working through the details of what carbon neutrality means and how it can be achieved, we know that natural and working lands must play an important role in meeting this new goal. Carbon neutrality will require both reductions in GHG emissions as well as resilient carbon storage and increased sequestration, which highlights the importance of resilient natural and working lands, in California and globally, as other national and sub-national governments set similar climate goals.

Photo: Florence Low / California Department of Water Resources

[3] IPCC, 2018: Summary for Policymakers. In: Global warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [V. Masson-Delmotte, P. Zhai, H. O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J. B. R. Matthews, Y. Chen, X. Zhou, M. I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.

II. NATURAL AND WORKING LANDS OBJECTIVES, VISION, AND STATUS

A. Objectives and Vision

The **objectives** of this Plan are to:

- Expand the use of natural and working lands for climate mitigation and adaptation by integrating climate goals into State-funded natural and working land conservation restoration, and management programs;
- Significantly increase and improve conservation, restoration, and management of California's natural and working lands, through State programs and other means, to enhance their resilience to worsening climate impacts, sequester carbon, and reduce GHGs;
- Identify next steps for taking a more comprehensive approach to addressing the policy challenges facing our natural and working lands, including their contributions to achieving carbon-neutrality and meeting our long-term climate objectives.

The State's **vision** for California's natural and working lands is to:

- **Protect** land from conversion to more intensified uses by increasing conservation incentives and pursuing local planning processes that maximize development where it already exists;
- **Enhance** the resilience of and potential for carbon storage and sequestration on lands through management and restoration, including expansion and management of green space in urban areas, and reduction of GHG and black carbon emissions from wildfire and management activities; and
- **Innovate** biomass utilization such that harvested wood and excess agricultural and forest biomass can be used to advance statewide objectives for renewable energy and fuels, wood product manufacturing, agricultural markets, and soil health, increasing the resilience of rural communities and economies and avoiding GHG emissions relative to traditional utilization pathways through these activities.

B. Status of California's Natural and Working Lands

CARB's natural and working lands inventory data indicate that in 2014, California's natural and working lands contained an estimated 5.5 billion metric tons of total ecosystem carbon in above and below-ground biomass and soils. However, California's lands are losing carbon, with an estimated net loss of approximately 170 MMT of carbon from 2001–2014. The majority of these losses are due to wildfire.[4] This loss of carbon is equivalent to a cumulative 630 MMT CO_2e of sequestered carbon removed from the land over the same period. However, not all the carbon lost is emitted to the atmosphere as CO_2. Some carbon leaves the land but

[4] California Air Resources Board. (2018) An Inventory of Ecosystem Carbon in California's Natural & Working Lands. https://www.arb.ca.gov/cc/inventory/sectors/forest/forest.htm

persists in durable wood products. Other losses are part of a normal ecosystem function, such as some level of loss due to fire, pests, and other disturbances. Fire is an integral and natural part of California's landscape. Tribes in California have used fire to manage landscapes for thousands of years. However, the industrialization of society and population growth increased the desire and ability to suppress fires across all natural and working lands. Fire suppression leads to landscapes that are misaligned with their natural state and increases the risk of high severity wildfires that emit immense quantities of GHGs and can damage ecosystems and the benefits they provide. Climate change is exacerbating the problem through longer droughts resulting in unprecedented tree mortality and some of the largest and most destructive wildfires in California's history (Figure 3).

picture shows the

Land conversion also impedes California's ability to store carbon and maintain resilient ecosystems. When natural and agricultural lands are transformed to more intensive uses, the soil and biomass carbon on the land is often degraded or lost; at the same time, GHG emissions from the new land use – such as vehicle miles traveled, and other effects of a suburban landscape – may increase. On average, approximately 50,000 acres of farmland and rangeland are lost per year, of that 21,000 acres per year are lost to urbanization.[5] If we are to depend on agricultural lands for food and fiber benefits as well as carbon sequestration and storage, it is important that farming and ranching remain robust and that rates of conversion diminish.

At the same time, California agriculture is a critical part of our environment and rural landscape. Agricultural lands in California comprise about 25.3 million acres, or 25 percent of the land in the State. California is home to one of five global Mediterranean climates in the world. This Mediterranean climate allows farmers and ranchers to produce a broad diversity of crops including nearly half of the nation's fruits, nuts and vegetables. However, as a land-

[5] Estimate based on California Department of Conservation Farmland Mapping and Monitoring Program data from 1992-2016, https://www.conservation.ca.gov/dlrp/fmmp/Pages/Farmland%20Conversion%20Reports.aspx

based industry sensitive to fluctuations in temperature and precipitation, this sector is also among the most threatened by climate change. Climate change poses threats to existing crop yields and brings uncertainties that increase the economic risk of agricultural operations in California. Water availability and temperature directly impact crop development and livestock production and they also influence the biological relationships that exist in agricultural systems including interactions with pests, diseases, and beneficial species. Additionally, changes in climate can create or exacerbate other environmental concerns such as decline in water quality, groundwater security, and soil health. The influence of climate change impacts on agriculture are complex and variable.

Photo: California Department of Water Resources

III. NATURAL AND WORKING LANDS 2030 GOAL FOR STATE-SUPPORTED ACTION

A. Scope of the 2030 Goal

While there are significant risks facing our natural and working lands, opportunity abounds to improve and increase their conservation, restoration, and management. Several external modeling and research efforts have attempted to quantify the total potential climate benefits we might achieve from different conservation, restoration, and management activities on California's natural and working lands. The estimates range from 31 to 147 MMT CO_2e by 2030.[6] Although these efforts have modeled different practices, baselines, and assumptions, and have achieved different results, they all point to the potential this sector has to offer. The 2030 goal established in this Plan focuses on just a piece of that opportunity—specifically, the scope and scale of a suite of State-supported land management, restoration, and conservation activities that can be pursued now to help change the current emissions trajectory and move the sector closer to becoming a resilient carbon sink.

The 2030 goal seeks to accelerate near-term action by orienting many State-funded conservation and restoration programs towards strategies that provide long-term climate benefits through protecting carbon stocks, increasing carbon sequestration, or reducing GHG emissions from California's natural and working lands, while enhancing their resilience to threats including worsening climate change impacts. While non-State funded strategies enacted by federal agencies, local jurisdictions, and private entities are critical, they are not directed by the State and thus are outside the scope of activities contemplated in the proposed pathways in this State Plan.

The declining health and net GHG emissions of the State's lands are expected to increase through a negative feedback loop as climate change further stresses these systems. With more frequent and intense drought, wildfire, pest outbreaks, and other impacts, it will only become more challenging to achieve our goals. The activity-based approach offers flexibility; the identified activities can be scaled up or modified as natural ecosystem processes and the effects of climate change continue to shape our landscapes, and as our understanding of carbon dynamics on these lands evolves.

The 2030 goal focuses on demonstrated and quantifiable land-based activities that provide near and long-term climate benefits and are currently funded by State agencies. The activities the State will promote as part of this strategy are described in the next section, **Pathways and Targets** and in **Appendix A**. Activities not currently included in modeling efforts and for which the ecosystem carbon science is still emerging will be integrated into the natural and working lands strategy on an ongoing basis.

[6] Cameron, D. et al. (2017) Ecosystem management and land conservation can substantially contribute to California's climate mitigation goals. *Proceedings of the National Academy of Sciences*; Marvin, D. et al. (2018). Toward a Carbon Neutral California. *Next10.*

B. Final 2030 Goal

To realize a long-term objective of resilient land-based carbon, the State must more than double the pace and scale of State-supported land activities by 2030 and beyond. The State will, at the least, strive to increase fivefold the acres of cultivated lands and rangelands under State-funded soil conservation practices, double the rate of State-funded forest management or restoration efforts, triple the rate of State-funded oak woodland and riparian restoration, and double the rate of State-funded wetland and seagrass restoration through 2030 (Figure 4). The implementation acreages associated with these goals are based on our understanding of recent implementation and restoration needs and are detailed in Figure 7 below.

To maintain our natural and working lands as a carbon sink, California strives to **at least double the pace and scale** of State-funded land restoration and management activities through 2030 & beyond.

Cultivated lands & rangelands

5x

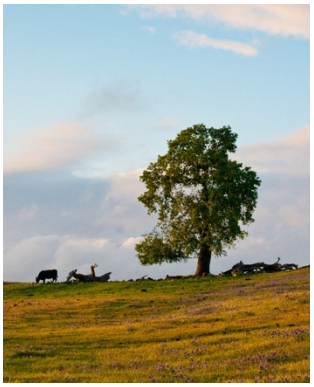
practices

Forested lands

2x

forests managed or restored

Savanna & woodlands



3x

Pace of reforestation of oak savannas and riparian areas

Wetlands & seagrass

2x

Rate of wetland and seagrass restoration

The projected climate outcomes of this level of effort is cumulative emissions of 21.6–56.8 MMT CO_2e by 2030 and cumulative emission reductions of -36.6 to -11.7 MMT CO_2e by 2045 based on the two scenarios developed through CALAND,[7] an integrated stock-change carbon and GHG accounting model, and the COMET-Planner[8] tool for agricultural land management practices (Figure 5). The benefits of the actions implemented are expected to grow substantially over time, through 2100 and beyond. The two scenarios and the tools and

[7] Draft CALAND Technical Document: http://resources.ca.gov/climate/natural-working-lands/
[8] COMET-Planner Technical Document: http://bfuels.nrel.colostate.edu/health/COMET-Planner_Report_Final.pdf

methods used to derive these numbers are described in **Appendix A**. Activities will be implemented not only for their climate benefits, but under an integrated multi-benefit approach that considers carbon alongside other benefits including critical ecosystem services, biodiversity, public health, and the economy.

Figure 5. Summary of Cumulative 2030 and 2045 results

Scenario	Acres implemented by 2030	MMT CO_2e: 2030	MMT CO_2e: 2045
Scenario A	2,742,000	21.6	- 36.6
Scenario B	4,306,000	56.8	-11.7

Note: negative values indicate GHG emission reductions or sequestration.

The scientific assessment supporting this Plan found that almost all the activities evaluated provide both near- and long-term climate benefits. Others, particularly forest fuel reduction treatments, involve near-term carbon costs but long-term benefits from removing excess material from overstocked forests that has resulted from decades of fire suppression. These fuel reduction activities, such as mechanical thinning and prescribed fire, reduce stand densities and fuel loads, restore the structure and composition of forest ecosystems, and lower the potential for damaging, high-severity fire,[9] which is currently the primary cause of GHG emissions and carbon loss from the land sector.[10] In the long-term, these activities result in climate benefits and healthier, more stable, and more resilient forests. Modeling results are in line with our understanding that many forests are currently overstocked (hold too much carbon) due to fire suppression, and therefore are highly susceptible to disturbance and loss over the long-term. Despite near-term carbon losses, thinning overstocked forests will result in lower forest densities, larger and more fire-resistant trees, and reduced fuel loads to minimize long-term black carbon and GHG emissions and create more stable carbon sequestration.

The 2030 goal is a statement of ambition informed by modeling and quantification tools, feedback from more than 20 State agencies, boards, departments, and conservancies, more than two dozen existing natural resources management plans including the Forest Carbon Plan,[11] and input from stakeholders through letters and meetings. It is a aggregated landscape-scale quantification that represents the estimated future GHG outcomes of the suite of actions implemented under each scenario. It is not an estimate of full potential for future state-wide GHG emissions and sequestration on natural and working lands, as it only estimates the effects of treatment on the lands which are treated and does not account for benefits that may accrue outside of treatment areas.

[9] Stephens et al. (2009), Campbell et al. (2007), Hurteau et al. (2008), Hurteau & North (2009), North et al. (2009)
[10] CARB (2018). An Inventory of Ecosystem Carbon in California's Natural & Working Lands.
[11] CNRA (2018). California Forest Carbon Plan.

C. Pathways and Acreage Goals

The 2030 natural and working lands goal will be met through activities that sequester carbon and avoid emissions through four broad pathways of natural climate solutions on California's lands: conservation, forestry, restoration, and agriculture. The practices included within each of these pathways and their intervention areas (acreage goals) are outlined below. Acreage goals for this Plan (Figure 7) focus on established practices currently implemented through State programs that could be modeled with existing carbon tools. However, it is expected that these practices will expand in the future with additional research, demonstration projects, and adaptive management. As these activities will be implemented for the range of ecosystem services they deliver in addition to carbon sequestration, selected co-benefits associated with each pathway are also highlighted below (Figure 6). Implementation of practices within these pathways is discussed in section **D. Implementation** and in **Appendix B**. For a technical description of the practices modeled in the accompanying scientific analyses, see **Appendix A**.

Figure 6. Co-Benefits Key

- **water** quantity and quality
- **air** quality
- **biodiversity and habitat** and **ecosystem health**
- **food** and **fiber** production
- **public health** and **resilience** to climate change

1. CONSERVATION

Land Protection

Protecting lands will help maintain carbon sinks within California's land base, provide habitat for wildlife, and increase food security. Directing new growth to existing communities without displacing current residents can prevent the conversion of natural and working lands and foster compact development that reduces vehicle miles traveled.

2. FORESTRY

Improved forest health and reduced wildfire severity

This suite of practices, including prescribed fire, mechanical thinning, and understory treatment, aims to restore health and resilience to overstocked forests and prevent carbon losses from severe wildfire, disease, and pests.

Enhanced carbon in forested ecosystems

Shifting timberlands to less intensive management regimes, including a shift from even to uneven-aged management, extending harvest rotation lengths, and establishing larger harvest buffers around riparian and habitat areas can increase carbon stored in forestlands.

Reforestation

Restoring ecosystem health of wildfire and pest-impacted areas by planting native and climate-adapted trees will be needed in some areas to prevent conversion of forest ecosystems to shrub or grassland and advance carbon storage within the landscape.

Increased biomass utilization

Carbon from wood and biomass generated by forest health, restoration, and hazardous fuels treatments can be stored in durable wood products, compost and other soil amendments, and animal feed and bedding, or be used to produce renewable energy. Expanding utilization of biomass from forest management activities can provide an alternative to mastication and pile burning. Using California-sourced wood in buildings also sequesters carbon and can reduce the embodied GHG emissions of materials used in buildings.

3. RESTORATION

Riparian restoration

Reforesting areas near rivers and streams can restore plant and animal habitat while protecting waterways from the impact of adjacent land uses.

Oak woodland restoration

The regeneration of California oak species can reverse carbon losses where oaks have been depleted due to land conversion, removal, or wildfire.

Wetland restoration

The restoration of wetlands in the Sacramento-San Joaquin Delta and along California's coast helps reverse land subsidence and reduce carbon emissions while improving flood protection and providing critical habitat. This pathway also includes transitioning to rice cultivation implemented in tandem with wetland restoration.

Seagrass restoration

In addition to sequestering carbon, restoring seagrass provides many benefits to a variety of marine life including species known to be sensitive to ocean acidification and commercially valuable fisheries.

Montane meadow restoration

Restoring degraded montane meadows will help secure the ecosystem services they provide including habitat diversity, carbon sequestration, and water storage and filtration.

Chaparral and shrubland restoration and management

Chaparral and shrublands are one of the most widely distributed terrestrial ecosystems in the State, especially within the Southern California. An ecosystem services approach to chaparral management that balances restoration, protection, and fuel management is needed to protect the benefits these ecosystems provide including biodiversity, carbon

sequestration, soil retention, and water provision.[12] Chaparral and shrubland restoration and management practices were not included in the acreage goals or modeling analysis for this plan due to an insufficient understanding of their effects on carbon dynamics.

Urban forestry and urban greening

In urban areas, expanding the tree canopy by planting trees along streets and walkways and in parks and yards and managing the existing canopy increases carbon sequestration in urban areas and can help reduce heat island effects, support water infrastructure, filter air, and improve health and well-being. Urban vegetation and soil management also provide important co-benefits such as stormwater management and cooling. However, only the carbon benefits of urban forestry were included in this analysis because additional research is needed to model the benefits of urban vegetation and soil management.

4. AGRICULTURE

Compost application

Compost application on cropland, rangeland, and pasture may increase carbon sequestration while enhancing water-holding capacity, forage production, and the release of nutrients in soils.

Agroforestry

Agroforestry involves integrating trees, shrubs, or other woody plants with livestock or agricultural crops. This includes the establishment of hedgerows or windbreaks on agricultural lands, protecting soils from erosion; and silvopasture, which combines trees, forage plants, and livestock in an integrated managed system.

Grazing land and grassland management

Prescribed or rotational grazing may increase carbon sequestration on working rangelands by preventing overgrazing and increasing grass productivity. Additionally, although they were not modeled in the analyses accompanying this Plan because their effects on carbon dynamics are not well understood, practices including native grassland restoration and management of grassland and rangeland for invasive species will be critical to restoring the health of these ecosystems and their ability to store carbon. More research is needed to understand and model the carbon impacts of these practices.

Cropland management

Sequestering carbon in cropland soils can be achieved through a variety of practices including cover cropping, mulching, no-till, and reduced till.

[12] Safford, H. D., Underwood, E. C., & Molinari, N. A. (2018). Managing Chaparral Resources on Public Lands. In *Valuing Chaparral* (pp. 411-448). Springer, Cham.

Figure 7. Implementation Acreage Goals for California's Natural Climate Solutions

Practice	Annual rate of implementation
Conservation of Natural and Working Lands	
Forestry	
Improved forest health and reduced wildfire severity	
Prescribed fire	23,800-73,300 acres/ year
Thinning	59,000-73,000 acres/ year
Understory treatment	23,500-25,300 acres/ year
Enhanced carbon in forested ecosystems	
Less intensive forest management	49,800-58,800 acres/ year
Biomass utilization	Additional 50% of slash diverted from pile burn/decay
Restoration	
Riparian restoration	
	3,100-6,100 acres/ year
Coastal wetland restoration	5,100-5,500 acres/ year
Delta wetland restoration	2,500-2,800 acres/ year
Meadow restoration	
Seagrass restoration	500-600 acres/ year
Urban forest expansion	20% increase in canopy cover by 2030
Agriculture	
Grazing land and grassland management	
Prescribed grazing	2,100-4,200 acres/ year
Agroforestry	
Silvopasture	400-800 acres/ year
Hedgerow establishment	800-1,700 acres/ year
Windbreak establishment	800-1,700 acres/ year
Riparian forest buffer	800-1,700 acres/ year
Riparian herbaceous cover	800-1,700 acres/ year
Cropland management	
Cover cropping	10,400-20,800 acres/ year
Mulching	10,400-20,800 acres/ year
No till	4,200-8,300 acres/ year
Reduced till	8,300-16,700 acres/ year
Compost application	
On annual cropland	10,300-20,700 acres/ year
On perennial cropland	21,000-41,900 acres/ year
On non-irrigated rangeland	2,100-4,200 acres/ year
On irrigated pasture	2,100-4,200 acres/ year

Reforestation goals are not included here as they were calculated as reforesting a majority of area within range of projected high-severity burn areas. Additionally, because the carbon impacts of **chaparral and shrubland management** could not be measured with current modeling tools, goals for these practices were not included in this draft.

D. Implementation

CalEPA, CARB, CDFA, CNRA, and SGC will collaborate to begin implementing the Plan through existing conservation, management, and restoration programs and new efforts, as needed. Implementation will include the organization of existing, and initiation of additional, State-funded activities on both private and public lands.

A general description of implementation is provided below. An overview of regional implementation is described in **Appendix B**, and specific departments and programs within CNRA that are expected to engage directly in implementation are described in **Appendix C**.

California Department of Food and Agriculture

Implementation at CDFA will build off of the Healthy Soils Initiative, announced by Governor Brown in 2015, which jump-started an opportunity to incentivize the management of farms and ranches specifically for carbon sequestration and augmentation of co-benefits such as increased water-holding capacity and soil fertility. Twenty-five million acres of California's natural and working land is utilized for farming and ranching. Numerous micro-climates allow for the production of more than 400 different commodities. The farmers and ranchers who work these acres use management practices to support and increase beneficial aspects of the soil and other ecosystem characteristics. The management practices selected are as diverse as the environments in which they are employed.

CDFA has worked closely with federal partners, sister agencies, and agricultural stakeholders to administer an incentive program that incorporates sound scientific findings and is inclusive of California's many crops and soil types. Practices that are incentivized include cover-cropping, addition of compost, conservation tillage, mulching, woody plantings, prescribed grazing, and restoration activities. For many of these funded activities, implementation options vary depending on the region, resource availability, and goals. For example, the types and planting schedules for cover crops varies depending on the desired co-benefits and local conditions. Additionally, the types and distributions of native species used in restoration activities is influenced by local micro-climate. No matter the location of an agricultural operation in California, there is ample opportunity for participation because the suite of practices offered are numerous.

Implementation will expand on program accomplishments from the last two years including but not limited to:

- ***More than 8,600 acres in soil conservation practices:*** With $5.8 million from California Climate Investments, the Department of Food and Agriculture's Healthy Soils Program has funded 110 projects including direct farmer incentives and farmer-to-farmer demonstration networks to increase adoption of soil management practices that sequester carbon. These projects are expected to sequester 18,683 MT of CO_2e over the 3-year project period.
- ***A $1.1 million partnership with UC Cooperative Extension to scale-up climate smart agriculture technical assistance****:* With California Climate Investments funding from the

Strategic Growth Council, the partnership is focused on implementing on-farm solutions to improve soil health, nutrient management, irrigation management, on-farm composting and manure management – smart farming practices that reduce GHG emissions.

The analysis to support this Plan used a sampling method to combine COMET-Planner outputs from twelve agricultural counties into a state-wide average. While specific levels of activity for each practice were required to generate the estimated climate benefits, CDFA will target implementation acres for healthy soils practices generally, rather than on practice specific acreages. Additionally, because a statewide average was used, the acreage target is a statewide rather than regional. Considering historic funding levels, implementation at the scales assessed would cost approximately $18 – $36 million per year for Scenario A and B, respectively (Figure 9).

Resources.

Figure 9. Implementation acreage goals for CDFA

Scenario	Annual Acres	Cumulative GHG Benefit by 2030	Cumulative GHG benefit by 2045	Estimated Annual Program Costs (millions)*
A: 500,000 acres by 2030	41,667	-5.3 MMT CO_2e	-12.0 MMT CO_2e	$18.2
B: 1,000,000 acres by 2030	83,333	-10.7 MMT CO_2e	-24.1 MMT CO_2e	$36.3

*Costs based on $436 per acre award.
Negative values indicate GHG emission reductions or sequestration. For details on the management activities this scenario examines, please see Appendix A.

California Natural Resources Agency

Within CNRA, implementation will build off decades of investments in programs and projects that yield climate benefits from natural and working lands. Since 2000, more than $30 billion has been invested in State water, parks, and resource bond funds for programs that protect forests, farms, ranches, and open space from development; restore wetlands, riparian areas, and streams; and enhance urban forests, waterways, and parks. Additionally, over the past four years, nearly $600 million has been directed towards CNRA programs through California Climate Investments. In addition to removing GHGs from the atmosphere and sequestering

carbon, these programs deliver many other benefits by creating new green space in cities, keeping farmland in production, helping ecosystems adapt to changing climate conditions, and restoring lands that have been degraded by fragmentation, over-grazing, topsoil loss, and severe forest fires. Leveraging and expanding existing programs within CNRA is critical to delivering the goals in this Plan. Each board, office, department, and conservancy within CNRA will continue to play a role in implementation of projects related to climate mitigation on natural and working lands; these roles are described in detail within **Appendix C**.

Implementation will expand on program accomplishments from the last four years including but not limited to:

- ***More than 81,000 acres of agricultural lands conserved:*** The Sustainable Agricultural Lands Conservation Program, administered by the Department of Conservation on behalf of the SGC, has provided funding to conserve prime agricultural lands, supporting food security and compact infill development for sustainable communities.
- ***More than 300,000 acres of forest lands treated and conserved:*** The Department of Forestry and Fire Protection (CAL FIRE) Forest Health Grant Program implements projects that restore forest health to reduce GHG emissions, protect upper watersheds, promote long-term storage of carbon in forests, and minimize the loss of carbon from large and severe wildfire through reforestation, fuel treatments, and pest management.
- ***Thousands of acres of meadows and wetlands restored:*** Several agencies within CNRA have invested in restoration of meadows in montane regions and wetlands along the coast and in the Sacramento-San Joaquin Delta, including state conservancies, the Wildlife Conservation Board, the Department of Fish and Wildlife, and the Department of Water Resources. This includes $21 million invested and 5,600 acres of wetland and meadow ecosystems restored over two cycles of funding through the Wetlands Restoration for Greenhouse Gas Reduction Program at the Department of Fish and Wildlife (CDFW). More than half of these funds have been allocated for projects within disadvantaged communities. Additionally, the Department of Water Resources has constructed nearly 2,000 acres of carbon wetlands on Sherman and Twitchell Islands in the Delta.
- ***More than $150 million invested in urban forestry and urban greening*:** Within CNRA, the Urban Greening Grant Program funds projects that establish and enhance parks, use natural solutions to improve air and water quality and reduce energy consumption, and create walking and biking trails to support active transportation. CAL FIRE's Urban and Community Forestry Grant Program provides funding to local governments and nonprofits for tree planting and urban forest expansion and management and urban wood and biomass utilization. Parks and green infrastructure created by both programs make cities more healthy and livable by increasing access to the outdoors, reducing the heat island effect, beautifying neighborhoods, and improving air quality.

In addition to leveraging existing programs, implementation at CNRA will require utilizing and developing regional, landscape, and watershed-level planning. California's diverse landscapes are characterized by distinct climates, soils, and topographic and geographic characteristics, supporting unique biological communities and ecosystem services. As such, the strategies for

managing natural and working lands will be implemented on a landscape scale to support multiple benefits and to reflect the regional social and cultural needs of the diverse populations they serve. Successful implementation will rely on collaboration with regional partners discussed in **Appendix B.** Additionally, the CNRA's ten regional conservancies, with a track record of working to conserve open space, restore lands, and increase access to parks and recreation, will be a key partner in local implementation (**Appendix C**).

Figure 10. The Cameron Nature Preserve in Malibu is ecosystems support.

Importantly, regional land use conservation planning and finer-grained, consensus-based localized plans will provide more detailed blueprints for implementation. CNRA will continue working with regional partners to help develop these plans where they do not exist. This may include leveraging Natural Community Conservation Plans in progress or approved by CDFW, which address a cumulative 9.5 million acres across California. Additionally, the Department of Conservation partnered with The Nature Conservancy to develop TerraCount, a scenario planning tool to allow cities, counties, districts, and other land use planners to model the GHG and natural resource implications of different development patterns and management activities. The Department collaborated with Merced County to pilot the use of this tool in the development of the county's climate action plan, and is investigating opportunities to support other jurisdictions to use TerraCount to inform their planning and decision-making processes. CNRA's Regional Forestry Capacity Program and the Department of Conservation's Watershed Coordinator Grant Program will also build local capacity for forest and watershed management.

Figure 11. 2030 Implementation restoration and management goals for CNRA

Pathways	Acres by 2030: Scenario A	Acres by 2030: Scenario B
Forestry	1,872,000	2,764,000
Restoration	340,000	512,000
Agriculture	32,000	32,000
Total	**2,244,000**	**3,308,000**

In addition to working towards these acreage goals, CNRA will strive to conserve and protect lands from conversion, reforest areas affected by severe wildfire, manage and restore chaparral and shrublands, and increase the urban forest canopy cover 20 percent by 2030.

E. Tracking Progress and Outcomes

CARB, CNRA, CDFA, CalEPA, SGC and other partnering agencies will measure and track expected GHG reductions of these management, restoration, and conservation activities from all current and future funding sources. Agencies will leverage existing quantification and reporting structures and utilize new tools and internal reporting systems to simplify and standardize tracking progress with a consistent and cost-effective monitoring regime.

The expected climate benefits from CNRA programs will be determined using CALAND and other methods, or future versions of CALAND as necessary. The climate benefits expected from activities funded through the Greenhouse Gas Reduction Fund will be determined through quantification methodologies used by California Climate Investment programs. CDFA will utilize COMET-Planner and existing and future quantification methodologies developed as part of California Climate Investments to quantify the expected climate benefits of its funded projects.

To evaluate actual GHG outcomes of projects, as compared to the expected climate benefits and assess progress towards meeting the 2030 goal, CNRA will use funding authorized in Proposition 68 for GHG emissions program monitoring to develop a consistent approach for monitoring climate outcomes of all bond funded programs. This will help agencies understand the effectiveness of specific programs in reducing GHG emissions and increasing the volume and resilience of land-based carbon.

Implementing agencies will annually report on progress. The reporting will include State-wide, regional, and land type-specific breakdowns of progress in terms of both acres protected and brought under management, and in expected GHG reduction outcomes for implementation. Agencies will also report on advancement of related non-carbon benefits, tracking progress towards goals in other existing resources management plans like the State Wildlife Action Plan, the California Water Action Plan, the California Biodiversity Initiative, and the Forest Carbon Plan, when possible.

In addition to tracking progress and estimating the benefits and impacts of the activities implemented to meet the 2030 goal, implementation will rely on programs and structures in place to monitor progress towards the long-term objective of achieving resilient net zero or negative emissions. The Natural and Working Lands Greenhouse Gas Inventory (NWL Inventory) will serve as the inventory of record for this sector, tracking sector-wide progress toward the long-term objective. The NWL Inventory will provide a retrospective snapshot of the status of California's natural and working lands in recent years. Over time, NWL Inventory will capture the effects of implemented interventions along with any impacts from regulatory and policy changes and other gains or losses that occur over the same period.

The State will continue to evaluate and improve the tools for quantifying the impacts and benefits of the activities that are called for in this Plan and incorporate new activities, data, and methods as needed.

IV. MOVING FORWARD

A. Implementation Needs and Considerations

This section outlines the following key recommendations for successful implementation of this Plan, including:

- Work with multiple partners;
- Augment State funding and resources;
- Coordinate cross-agency implementation;
- Prioritize capacity building, technical assistance, and collaborative planning;
- Recognize restoration economies and build workforce capacity;
- Invest in education and outreach;
- Leverage cross-sector interactions;
- Continue to support ongoing research; and
- Consider and measure non-carbon benefits.

Work with Multiple Partners

While this Plan focuses on State-funded efforts towards emission reductions and carbon sequestration on natural and working lands, the role of local, federal, tribal, and private partners in creating impact at scale cannot be understated. Working with these partners, implementation should:

- ***Leverage and support technical assistance providers:*** California's ninety-eight Resource Conservation Districts will be key partners in implementation given their track record of providing technical assistance to local landowners and implementing agriculture, forestry, and restoration projects in regions across the state (Figure 12). Additionally, entities like the University of California Cooperative Extension have a history of providing technical assistance to landowners on agricultural and natural resource management.

Figure 12. Outreach to farmers provided by California *Association of Resource Conservation Districts.*

- ***Leverage local funding:*** State funds should leverage local or regional funding, such as the San Francisco Bay Restoration Authority's Measure AA to achieve these goals. That funding measure will provide $25 million a year for 20 years to fund wetland restoration in the San Francisco Bay Area.

- ***Expand collaboration across ownerships:*** Nearly half of all lands in the state are owned by the federal government, and less than three percent of forests in California owned by the State. Thus, the State must work closely with private landowners and federal partners including the U.S. Department of Food and Agriculture (USDA) Forest Service, USDA Natural Resources Conservation Service, and U.S. Bureau of Land Management to manage lands across ownership at the landscape and watershed scale.
- ***Coordinate across local and regional governments:*** By leveraging local planning processes and SB 375 Sustainable Communities Strategies, the State can discourage urban growth on critical natural and working lands.
- ***Integrate and empower tribal perspectives:*** The State can partner with California Native American tribes, elevating the role of tribal knowledge of fire and related cultural practices in resource management.
- ***Assist private landowners:*** Most non-federal forest, agricultural, and rangelands in California are privately owned. New incentives will be needed to encourage farmers, ranchers, and forest owners to manage their lands for increased carbon sequestration. For example, providing private landowners with incentives for forest protection through easements or working forests could help prevent land fragmentation and conversion to non-forest land uses.
- ***Build and strengthen national and international partnerships:*** Jurisdictions around the world are also working to make their natural and working lands more resilient and sustainable. Collaborating with these national and sub-national entities and creating a shared commitment to action is a key element in building global momentum to protect natural and working lands.

Augment State Funding and Resources

Natural resources bonds have provided billions of dollars for natural resources conservation, restoration, and management projects since 2000, with Proposition 68 being the most recent voter-approved initiative. Through this effort, agencies implementing programs with new bond funding will begin explicitly including climate as part of their implementation objectives. In addition, as of fiscal year 2018-2019, the State has committed roughly $800 million of California Climate Investment funds, or about 9 percent of the total Greenhouse Gas Reduction Funds appropriations, for climate mitigation activities on natural and working lands. This includes $200 million from the first year of funding pursuant to SB 901, which commits $200 million annually for five years.

While California has been a global leader in public funding for natural and working lands, the scale of implementation called for in this Plan will require significantly more resources. These sources of funding are critically important to making needed progress; however, they are relatively short in duration and renewed funding is not guaranteed. A dedicated commitment of long-term funding would provide a level of certainty for implementing agencies and allow for sufficient long-term staffing for implementation, monitoring, and program improvement.

Similarly, the associated encumbrance and liquidation periods associated with existing funding sources are short: for California Climate Investments the period is only three years. In many

cases, this provides insufficient time for project solicitations, application process and review, selection and contracting, and ultimate implementation. This issue is compounded by the fact that many of the activities funded are weather dependent, which can further delay implementation. While programs can implement some efficiencies, these projects also generally take time to implement and the benefits accrue over longer timeframes, in many cases beyond the allowable contract period. An extended encumbrance and liquidation period would allow more time for administering agencies to coordinate and streamline timeframes and processes and, on the back end, allow additional time for monitoring and assessing project outcomes.

Coordinate Cross-Agency Implementation

Our landscapes are diverse and complex systems, managed by many agency programs pursuing land-based projects for different objectives, often leading to significant inefficiencies and incongruous guidelines. For any project that is funded, there are likely opportunities to meet multiple State objectives, including climate mitigation and adaptation. Moving away from siloed endeavors of individual agencies, cross-agency efforts can provide the greatest opportunities to impact natural and working lands effectively and efficiently to reach our 2030 and long-term objectives. Building more systematic cross-agency coordination could help speed up implementation and streamline application processes, maximizing both the available funds and the benefits of the investment. This type of coordination can also reduce the risk of unintended adverse impacts, as interdisciplinary expertise would provide a wider range of perspectives on project outcomes and risks. Options for improving the current process include:

- Developing a single "common application" for all resources-related grants;
- Harmonizing application and award timelines;
- Increasing cross-agency consultation on proposed projects;
- Streamlining project permitting processes; and
- Sharing data on funded and proposed projects though a common mapping platform to help coordinate synergistic and complementary investment areas and prioritize future funding decisions.

These multi-entity efforts take time and patience to develop. While we expand these collaborative efforts, individual agencies and existing programs can be improved and streamlined to meet our goal of increased pace and scale of implementation. Program procedures and methodologies can be reviewed for opportunities to improve transparency, understanding of the process for funding or administration, coordination between agency requirements and reporting, funding schedules and flexibility, and overall administrative efficiency. These efforts will contribute to the Plan goal and encourage participation from stakeholders and organizations.

Prioritize Capacity Building, Technical Assistance, and Collaborative Planning

With lands extending across many jurisdictional boundaries, capacity building, technical assistance, and collaborative planning are critical to implementing the scale of ecologically

meaningful activities we are targeting. Identifying and bringing together multiple participants, each with their own views and objectives, to set priorities, gather data, develop plans, secure funding, and implement activities is not an easy process. However, funding is often not available for these coordinating activities. To the extent feasible, the State should make funding, resources, and staff available to support collaborative processes and planning. Support could include efforts to build capacity, provide technical assistance, or offer funding assistance through cost-sharing, block-grants, or other funding mechanisms. Financial and technical assistance will also be needed to help small forest and agricultural landholders engage in these efforts and implement forest and soil health and resilience improvement work on their lands.

Successful regional collaborations such as the Sierra Nevada Watershed Improvement Program and county-level efforts such as the Resilient Merced project should be encouraged and replicated in other areas, tailored to meet local priorities. Recent state efforts, such as the Watershed Coordinator Grant Program at the Department of Conservation or the Natural Resources Agency Regional Forestry Capacity block grant program are promising endeavors for building regional capacity across natural and working lands. These and other existing efforts serve as valuable templates and stepping stones towards improved cooperation and the formation of new successful collaborations.

Recognize Restoration Economies and Build Workforce Capacity

The restoration economy—defined as jobs created through environmental conservation, restoration, and management—will be an important consideration for implementing this Plan and future research. Actions on natural and working lands have the potential to produce economic benefits in California's communities and create new job opportunities for farmers, ranchers, and foresters. Studies on restoration economies show a range of results but share a similar message: restoration creates jobs, stimulates economic growth and employment in other industries, produces localized community benefits, and provides enduring social and environmental value.[13][14] Employment effects of reforestation, land, and watershed restoration projects and sustainable forest management, which create 10 to 40 jobs for every one million dollars invested, may be greater than traditional industries like oil and gas that produce around 5 jobs per million dollars invested.[15, 16, 17]

[13] BenDor, T.K. et al. (2014). Exploring and Understanding the Restoration Economy.
[14] EcoTrust. Oregon's Restoration Economy.
[15] Heintz, J., Pollin, R. & Garrett-Peltier, H. (2009). How infrastructure investments support the US economy: employment, productivity and growth. *Political Economy Research Institute, University of Massachusetts Amherst.*
[16] BenDor, T.K. et al. (2014)
[17] Nielsen-Pincus, M., & Moseley, C. (2010). Economic and employment impacts of forest and watershed restoration in Oregon.

Figure 13. Young people employed through the California Conservation Corps work on projects from dead tree removal and forest health management to tree planting, trail building, and floodplain and riparian restoration. They receive on-the-job training as well as

As this Plan is implemented, rebuilding workforce capacity in natural resource and conservation agriculture industries will be critical. Currently, the farm production, forestry, fishing, and hunting and support services industry adds over $21 billion to California's economy. Forests and forest products sectors provide nearly 286,000 jobs, and agricultural production and processing over 745,000 jobs. Despite the economic benefits these resource industries can provide, many of them have declined in recent years. For example, jobs in wood harvesting saw almost a 50 percent decrease from 1998 to 2015,[18] and land managers report a shortage of skilled local crews to implement forest thinning and prescribed burn work at the scale needed to restore forest health. The State can invest in assessments of workforce needs, training programs, and career pathways to help create the workforce pipeline needed to support the restoration and management goals described in this Plan. Additionally, the State can expand the use of State training programs such as the California Conservation Corps and work to ensure that these programs lead to career pipelines. This increased workforce capacity could significantly expand well-paying employment opportunities, providing economic benefits to communities across the State.

Invest in Education and Outreach

Robust and coordinated education and outreach are essential to building buy-in for, and a shared understanding of, the need for climate action on natural and working lands. Targeted outreach and engagement can help foster a greater understanding of:

- How our natural and working lands are directly tied to our well-being and our way of life, even for those living in places isolated from these lands in urban and suburban areas;
- The risks associated with the impacts of climate change across our lands and how they will be felt in communities across the State;
- What can be done at the individual, local, regional, and State climate risks and manage natural and working lands for resilience; and
- How the State can tailor its strategies for natural and working lands to best serve the regional needs of California's communities.

[18] CAL FIRE (2018) California's Forest and Rangelands: 2017 Assessment. http://frap.fire.ca.gov/assessment2017/FinalAssessment2017/Assessment2017.pdf

Education and outreach efforts should be coordinated and extend across agency missions and be targeted towards communities and local, regional, and tribal governments, and other State agencies. The State should help all Californians, even those in urban centers that seem far removed from these lands, understand that natural and working lands have a direct and meaningful impact on public health and wellbeing. While not always obvious, Californians rely on these ecosystems for the life-sustaining benefits they provide in the form of human health, safety, water quality and supply, air quality, and food and fiber, and California's economy. These lands are inextricably connected to our agricultural production, tourism, and recreational opportunities. The State may increase support for natural and working lands management if the public is engaged in forming these policies and if the State delivers on objectives to improve the environments that supply these critical benefits.

Importantly, certain communities such as disadvantaged, low-income, and rural populations are especially vulnerable to the impacts of climate change, including those impacts that are tied to our natural and working lands. Oftentimes, populations that are vulnerable to climate impacts also experience the cumulative effects of several social and environmental burdens. For example, small forest landholders may face significant financial and regulatory barriers that impede them from managing their lands for resilience, while also living in areas that are highly vulnerable to the risk of severe wildfire. Rural residents may face a legacy of environmental pollution from mining or logging, as well as the decline in socioeconomic conditions resulting from the loss of these industry jobs. In cities, low-income communities and communities of color disproportionally live in areas with a deficit of parks and green space and are therefore burdened by the effects of urban heat islands, which can be particularly harmful for elders, children, and people without access to air conditioning (Figure 14). Thus, continued efforts to engage disadvantaged, low-income, and rural communities in shaping the natural and working lands policies that affect them will help the State better meet multiple social and environmental goals. Additionally, targeted outreach to help these communities better understand and access program information relevant to them is needed moving forward.

Figure 14. Tree planting in the Imperial Valley through CAL FIRE's Urban and Community Forestry Grant Program will help mitigate the urban heat island and increase access to green space.

Other programs funded by California Climate Investments serve as examples of State programs that focus on prioritizing investments in communities most impacted by pollution and poverty and most vulnerable to the effects of climate change. For example, the Transformative Climate Communities Program funds development and infrastructure projects that achieve major environmental, health, and economic benefits in California's most disadvantaged communities and award competitive grants to specified eligible entities for the development and implementation of neighborhood-level transformative climate community plans. Additionally, SB 1072 directs SGC to administer a regional climate collaborative

program to assist under-resourced communities within a region to access statewide public and other grant monies. These regional climate collaboratives will provide capacity building services to assist in building community-driven leadership, knowledge, skills, experience, and resources to identify and access public funding for climate change mitigation and adaptation projects within under-resourced communities. There is untapped potential to build cross-collaboration opportunities between these funding and technical assistance programs and activities to manage and restore natural and working lands.

Leverage Cross-Sector Interactions

In order to ensure the success of achieving the deep emission reductions needed in the long-term, we need to understand how actions on natural and working lands interact with other sectors as defined in CARB's GHG emissions inventory including transportation, electricity, commercial and residential, industrial, agricultural, and waste management sectors. Activities on natural and working lands have impacts on not only the short- and long-term carbon stocks and sequestration of the area affected but may also have cascading benefits and impacts on numerous other sectors.

For example, a well-known cross-sector interaction is the impact of urban forests and vegetation on energy use, water use, and stormwater capture. Additionally, converting forest or agricultural land to developed land will release soil and biomass CO_2 and may result in increased GHG emissions from the transportation sector. At the same time, forest management practices intended to increase the resilience and volume of carbon in forests can generate biomass that will intersect with the transportation, energy, and waste sectors, and affect community air quality. Benefits and impacts to water supply and quantity should also be considered.

Another example is mulched biomass, which can be used as a ground cover in numerous rural and urban settings for landscaping purposes, and in an agricultural setting to add organic material to the soil or as animal bedding. This presents an inter-sector opportunity to benefit forestlands through creating more resilient conditions, while providing benefits to rural and urban communities through water-smart landscaping and benefit agricultural lands through increased soil carbon sequestration and reduced carbon loss from the soil.

We have begun to investigate the cross-sector interactions of natural and working land conservation through the use of RapidFire,[19] a model designed to evaluate high-level urban land use scenarios across a range of metrics, including carbon. Comparisons of the outputs of RapidFire and CALAND, indicate that in addition to natural and working land carbon stock and sequestration impacts, emissions impacts when accounting for the other sectors such as energy, transportation, and waste can be much larger.

[19] Information on RapidFire is available here: https://www.calthorpe.com/sites/default/files/Rapid%20Fire%20V%202.0%20Tech%20Summary_0.pdf.

These cross-sector interactions are not an immediate focus of this Implementation Plan; however, gaining a better understanding of and accounting for these interactions will be part of the complete integration of natural and working lands into the State's broader climate strategy. This larger view will lead to a clearer identification of trade-offs among sectors and could lead to more innovative and comprehensive policy solutions. In combination with expanded efforts across all levels of government, an understanding of cross-sector interactions can result in efforts that optimize multiple benefits across sectors and across the State.

Continue to Invest in Research

Ongoing research is needed to inform State policy on how to better manage natural and working lands for carbon in the face of climate change and other impacts. Recently, SGC's Climate Change Research Program, funded through California Climate Investments, has funded various groundbreaking research initiatives that aim to reduce GHG emissions and advance equitable outcomes for vulnerable communities. Research teams selected for funding will explore topics as varied as developing tools for resilient forest management, sustainable use of biomass, improving carbon sequestration on farmlands, and advancing more efficient cooling technologies in low-income and disadvantaged communities. SGC has awarded two rounds of funding for a total of $27.6 million for the fiscal year 2017 to 2019. Six of the fourteen research projects, totaling $15 million, are directly related to natural and working lands implementation activities. Projects will explore topics including integrating land use and climate change on California's Central Coast, improving San Joaquin Valley agriculture under climate change, mobile biochar production for methane emission reductions and soil amendment, and integrating land use planning to support climate resilience in ecosystems and local communities. These projects provide opportunities to share data and knowledge across research and planning entities and help set the stage for cross-collaborative projects in the future.

Additionally, technical reports were recently released for over 40 State-funded research projects conducted though California's Fourth Climate Change Assessment. Several of these reports discuss climate risks and adaptation approaches for California's natural and working lands, exploring topics such as fuel treatments for forest resilience and climate mitigation, innovations in measuring forest carbon stocks, the climate mitigation and resiliency benefits of applying composting and soil amendments on rangelands, and ecosystem carbon related to land acquisitions in coastal California. Continuing to include natural and working lands within these and other State-led climate change research programs will help ensure that California's management policies are supported by the best available science.

Consider and Measure Non-Carbon Benefits

A goal of this plan is to integrate climate change considerations into natural and working land management strategies. As agencies, boards, departments, and conservancies adopt a unified multi-benefit approach that considers climate alongside other critical ecosystem services, biodiversity, public health, and the economy, we can move forward and leverage efforts for maximum and sustained benefit. CARB has started to develop co-benefit assessment methodologies for evaluating California Climate Investment project co-benefits. The State will

continue to develop metrics and tools both to help prioritize future projects and plans based on multiple objectives including carbon, and to measure these non-carbon benefits within funded projects.

B. Next Steps

This Plan is the culmination of years of agency coordination and is the start of increased collaboration, work, and effort in this space. While progress can be made through direct State investment as laid out in this Plan, State funding alone is not enough. California must commit to advancing this critical natural and working lands pathway, to protect the State's citizens and landscapes on our path to carbon neutrality. Such an ambitious goal will take a concerted effort and dedicated resources and staffing from all relevant agencies.

CARB will coordinate participating agencies and, through a transparent public process, work to identify concrete next steps. Priority actions include:

- Develop an estimate of the full potential for natural and working lands to contribute to our climate goals, including carbon neutrality;
- Develop a historic baseline of greenhouse gas emissions from California's natural fire regime reflecting conditions before modern fire suppression pursuant to SB 901 (Dodd, Chapter 626, Statutes of 2018) to better understand the level of carbon loss expected from naturally occurring fire; and
- Consider other mechanisms for driving additional actions in this sector including but not limited to: new markets and funding mechanisms such as green loans; policy levers such as mitigation and carbon banking; and regulatory changes such as regulatory alignment or revisions of the California Environmental Quality Act.

Additional items may include but are not limited to the following:

- Identify actions for supporting the strategies described under the Implementation Needs and Considerations section;
- Expand the current State-supported effort to additional State agencies and determine how non-State activities might be incorporated;
- Explore methods and tools for assessing cross-sector interactions and understanding the full climate impacts and benefits of land-based restoration, conservation, and management decisions;
- Work to align appropriate State strategic plans with the State's climate objectives and goals for natural and working lands;
- Further develop and refine tools to encourage local jurisdictions to avoid conversion of agricultural and other lands;
- Continue to develop and improve CARB's retrospective natural and working lands GHG emissions inventory to reduce uncertainties in the estimates;

- Expand technical capacity in conducting scenario analyses including retrospective quantification of effects of policies and programs, business-as-usual projections, and policy scenario projections; and
- Refine and update quantification tools and methods as needed including the potential for using remote-sensing technologies to complement periodic on-the-ground assessments of carbon stores to assess the outcomes of implemented actions.

CARB staff will expand and refine this approach with concrete actions, responsible agencies, and an associated timeline for discussion at a CARB Board Hearing in early to mid-2019.

Photo: California Department of Water Resources

APPENDIX A. DESCRIPTION OF TOOLS, METHODS, AND MODELED ACTIVITIES

A. California Natural and Working Lands Carbon and Greenhouse Gas Model (CALAND)

The California Natural and Working Lands Carbon and Greenhouse Gas Model (CALAND) is an empirically based landscape-scale carbon accounting model that assesses the projected GHG benefits of certain conservation, restoration, and management activities on California's natural and working lands. It is a database carbon accounting model that quantifies the changes in landscape carbon dynamics (stock and flux) resulting from different levels of management, land use and land cover changes, and potential climate change scenarios. Version 1 of the model was developed from August 2016 to December 2016 and Version 2 through October 2017; Version 3 was completed in Fall 2018.[20]

Rather than showing absolute GHG emissions, CALAND compares the difference in expected GHG emissions that result from alternative land use and management scenarios. The scenarios represent different input levels of State-funded conservation, restoration, and management activities that are not included in the baseline case. Constructing alternative scenarios to run in comparison to the baseline requires identifying the management activities to be implemented **(Section E of this Appendix)** and the scale of implementation for each activity (e.g., acres under a given management practice or acres of avoided conversion).

The Plan examines two alternative scenarios compared to a baseline of no programmatic intervention. The baseline represents avoided GHG emissions, sequestration, and storage resulting from no additional State conservation, restoration, and management beyond mandatory regulations and policies, such as compliance with California Forest Practice Rules. Acreage inputs for the baseline do not consider any State or non-state management presently being implemented other than forest management activity implemented by the USDA Forest Service on federal lands (based on historic levels).

The two alternative scenarios represent different levels of implementation based on regionalized acreages of State- funded conservation, restoration, and management activities. The acreage-based activity goals are then modeled in CALAND to estimate the greenhouse gas costs and benefits of implementing those practices on the given acreages.

Using aggregated potential acreages of implementation for each management and restoration practice, and assumptions for avoided anthropogenic land use change the scenarios include:

- **Scenario A**: This scenario represents an acceleration of historical levels of conservation, restoration, and management on public and private land beyond current expenditures. Acreage inputs for Scenario A reflect an ambitious but manageable goal given a

[20] A draft technical description of CALAND Version 3 is available here: http://resources.ca.gov/climate/natural-working-lands/

significant but reasonable increase in future State spending from various sources. This scenario models a 50% decrease in rate of urban and suburban development.

- **Scenario B**: This scenario represents large landscape-scale plans with a more aggressive approach than Scenario A, requiring additional funding for existing programs and planned activities as well as new programs and policies. Scenario A reflects the full potential of implementation, restoration, and management of California's Natural and Working Lands given an increase of spending and coordination beyond projected funding. This scenario models a 75% decrease in rate of urban and suburban development.

The process for developing the acreage targets for alternative scenarios are described below, in **Section C**. The alternative land use and management scenarios include activities implemented through 2030. State agencies may consider applying management practices after the 2030 timeframe to assess the longer-term impact of ongoing management, as the duration of impact of alternative land management and restoration practices is not assumed to be indefinite. CALAND outputs are the expected GHG benefits, expressed in MMT CO_2e, resulting from implementation of given alternative land use and management scenario.

B. COMET-Planner

COMET-planner[21] is an online GHG and carbon sequestration estimation tool developed by the United States Department of Agriculture (USDA) and Colorado State University. It was created to help farmers and ranchers estimate the potential climate benefits of a variety of agricultural management practices on cultivated land and grazing land, including some restoration and vegetative cover activities. Since its first release it has been revised and fine-tuned in a collaborative effort that involved CDFA and CARB to support project-level carbon benefit quantifications for CDFA's Healthy Soils Program.

The GHG emission coefficients utilized by COMET-Planner are based upon multiple runs of COMET-Farm, a whole farm GHG auditing tool which employs USDA Entity-scale GHG Inventory methods, biogeochemical modeling, and regional soils and climate information. Outputs of COMET-Planner are annual averages of emissions for a practice based upon a 10-year duration of that practice. COMET-Planner accounts for field level results only, transportation and other off-farm factors are not included in the quantification.

For the 2030 goal, COMET-Planner provided projections for a number of agricultural practices that are under consideration to help the State meet climate targets. Similar to CALAND, two alternative scenarios were assessed comparing carbon sequestration and avoided GHG emissions to a baseline. The baseline for these practices is 8,900 acres which represents the implementation acreages from the first round of the Healthy Soils Program, a program newly funded in 2017.

[21] For more information on the COMET-Planner tool see http://bfuels.nrel.colostate.edu/health/COMET-Planner_Report_Final.pdf

To translate target implementation acres to potential carbon benefits for agricultural management practices, two scenarios were modeled using COMET-Planner outputs. In Scenario A, 500,000 acres of agricultural management practices would be incentivized by 2030. In Scenario B, 1 million acres would be incentivized by 2030. CDFA used a sampling method to combine COMET-Planner outputs from twelve agricultural counties into a state-wide average.

In both modeled scenarios the same assumptions are used – the requirements of participation in the Healthy Soils Program. The program guidelines require that most practices be annually implemented for three continuous years. Four of the funded practices, those involving woody plantings, are required to be maintained for a minimum of 10 years. In the modeling effort, the carbon benefits of the practice increased for each year of the project life. The benefits that accrued to the end of the project life were assumed to remain stored for the full 12-year period (2019-2030). In both scenarios, it is assumed that more than one practice could be, and often would be, implemented on a unique acre. Acreage was also phased in evenly over the period from 2019 – 2030, simulating consistent state investment levels. In actuality, practices may be continued longer by the farmer (achieving greater benefit), but in the modeled scenarios, only the benefits from State investments are counted.

Table 1 below shows the practices that were included in the modeling exercise along with the percentage that each practice contributed to the two scenarios. Compost application weighs heavily into both scenarios, with 75% of the acres being compost application on cultivated land.

Results of the COMET-Planner exercise are summarized in Table 2 below. In Scenario A, 41,667 new acres would be enrolled into the Healthy Soils Incentive Program each year culminating in a benefit of -5.3 MMT of CO_2e at the end of 2030. In Scenario B, 83,333 new acres would be enrolled each year resulting in a total benefit of -10.7 MMT of CO_2e. In Scenarios A and B, the proportional benefit per acre is the same, at -10.7 metric tons of carbon per acre over the implementation period. An estimated program cost can be calculated using historic funding levels from the Healthy Soils Program. In Scenario A the cost would be approximately $18M per year and in Scenario B the cost would be $36M per year.

Table 1. Agricultural Management Practice Target Acreage for Scenarios A and B

Category	Practice	Percent of Target Acreage		A: ½ Million Acres	B: 1 Million Acres
Cropland Management	Cover Cropping	.25		125,000	250,000
	Mulching	.25		125,000	250,000
	No Till	.1		50,000	100,000
	Reduced Till	.2		100,000	200,000
Grazing Land Management	Prescribed Grazing	.05		25,000	50,000
	Silvopasture	.01		5,000	10,000
Woody Cover	Hedgerows	.02		10,000	20,000
	Windbreak Establishment	.02		10,000	20,000
	Riparian Forest Buffer	.02		10,000	20,000
Herbaceous Cover	Riparian Herbaceous Cover	.02		10,000	20,000
Compost Application	Compost on Annual Cropland (C:N<11)	.75	.027	13,500	27,000
	Compost on Annual Cropland (C:N>11)		.221	110,500	221,000
	Compost on Perennial Cropland (C:N<11)		.259	129,500	259,000
	Compost on Perennial Cropland (C:N>11)		.244	122,000	244,000
	Compost on non-irrigated rangeland	.05		25,000	50,000
	Compost on irrigated pasture	.05		25,000	50,000
TOTAL ACRES				895,5000	1,791,000

Table 2. Summary of Scenario Outcomes for Agricultural Management Practices

Scenario	*Annual Acres*	*Cumulative GHG Benefit*	*Estimated Annual Program Costs**
A: 500,000 acres	41,667	-5.3 MMT CO_2e	$18.2M
B: 1,000,000 acres	83,333	-10.7 MMT CO_2e	$36.3M

*Based on $436 per acre award

C. Implementation Targets for Conservation, Restoration, and Management

To develop State targets for the extent of implementation of different land management activities, CNRA and CDFA surveyed their programs, departments and conservancies in early 2018 to assess the area of conservation, restoration, and management activities they would expect to complete by 2030 under both current and more ambitious funding levels. The purpose of this task was to set goals that are grounded in existing programmatic efforts for natural and working lands. The potential scale of implementation was estimated for all management activities included in the Plan **(Figure 7)** for which the State anticipates funding, regardless of whether the programs that fund these activities have a primary goal of climate mitigation.

Information was gathered to inform two alternatives to compare to the baseline. Scenario A represents scaling up historical levels of conservation, restoration and management beyond current implementation. Scenario B accelerates implementation even further, representing large landscape-scale plans with a more ecosystem-needs based approach than Scenario A, requiring additional funding for existing programs and new programs and policies. Some departments and conservancies based this scenario on resource management and restoration plans or goals such as the Baylands Ecosystem Habitat Goals Project, State Wildlife Action Plan, or Tahoe Central Sierra Initiative. Both scenarios assume availability of funding and on-the-ground personnel and resource management professionals needed to complete this work.

To help agencies understand what is needed for successful regional implementation, a stakeholder outreach effort that included regional meetings and additional conversations provided important feedback on the proposed regional acreage targets. This process included engagement of practitioners, Resource Conservation Districts, land trusts, NGOs, nonprofits, and local, regional, and tribal governments. Stakeholders were asked to provide feedback on whether the business-as-usual and ambitious scenarios consider regional priorities and conservation, restoration, and management projects on natural and working lands. Additionally, this process examined existing regional conservation, restoration, and acreage goals to inform the goals, especially in Scenario B.

CARB, CNRA, and CDFA and other agencies used projections from CALAND and COMET-Planner derived from finalized acreage targets to better understand the estimated impact state-funded activities could have on meeting the 2030 NWL goal. These projections help show the potential aggregate GHG outcomes of management practices pursued by various State agencies and departments through 2030, 2045, and 2100. These projections provide an

outlook of how far State efforts may help California reach its carbon outcomes for natural and working lands, and whether these activities will need to be scaled up to reach 2030 or more ambitious carbon goals.

D. Combining Results

Model outputs based on acreage level inputs (Table 3) represent the associated net GHG costs and benefits from a suite of activities projected out to 2030 and 2045 using the combined annual average CALAND and COMET-Planner results. Both scenarios assume the State will reach its acreage-based activity goals by 2030, with continued benefits accruing to 2045. CALAND modeling efforts predict sustained and increased reductions in GHG emissions beyond 2045 with an estimated average cumulative GHG reduction of -664 to -655 MMT CO_2e by 2100. However, this estimate comes with a high degree of uncertainty. Long-term estimates will continue to advance as modeling efforts and monitoring technologies improve.

Table 3. Model Outputs for Scenarios A and B

Scenario	Total Acres Implemented by 2030	MMT CO_2e by 2030	MMT CO_2e by 2045
Scenario A	**2,744,000**	**21.6**	**-36.6**
Scenario B	**4,408,000**	**56.8**	**-11.7**

Note: negative values indicate GHG emission reductions or sequestration.

E. TECHNICAL DESCRIPTION OF MODELED MANAGEMENT ACTIVITIES

This section describes the proposed land use, management, and restoration activities the State will leverage to meet the goals of the Implementation Plan. The activities are organized into groupings for similar resources and practices: conservation; forestry; restoration; and agriculture. CALAND and COMET modeling produced estimated carbon benefits of the activities included in this Plan (Table 4).

Some of these practices may be layered on the same area, which may change the expected duration of and GHG impacts from what is listed for individual practices here. For example, putting in place a conservation easement that mandates one of the listed management or restoration practices would increase the permanence of expected GHG outcomes, since that management practice would be required to be ongoing, rather than a one-time activity.

Table 4. Modeled Management Activities

LAND PROTECTION

Avoided Conversion	
Activity	Reduced conversion of natural and working lands to urbanized land. This is modeled as a reduction in the business-as-usual (BAU) urban area growth rate, for example, by reducing the rate of urbanization to 75% of the BAU. The land types affected differ by region and ownership, and the specific land type areas are converted in proportion to each year's land type area distribution within a given region and ownership. Reduced conversion can also be directed to a specific region and ownership.
Carbon pool(s) impacted	Above- and below-ground live vegetation, dead biomass, soil carbon. If forest is converted in the course of urbanization, the disposition of the removed trees is the same as for even-aged forest management (i.e., full clearing).
Duration of effect	This is determined by the prescribed reduction in urban area growth rate selected for the Alternative Scenario. If the reduction halts growth indefinitely, then no more lands will be converted to urban area, otherwise a specified level of conversion continues. If the growth rate increases during a simulation, then conversion avoided earlier in the simulation will be subject to conversion later in the simulation. Note: this potential future loss of avoided conversion is currently viewed as a gap for improvement within CALAND, since the State also wishes to model direct conservation in alignment with existing land use priorities. Direct conservation will be able to be implemented in CALAND Version 3, but preservation of certain acreages will be manual rather than programmed into the model. This is a priority for addressing in future versions of CALAND.
Implementing agencies	CDFW, Department of Conservation (DOC), Department of Forestry and Fire Protection (CAL FIRE), State Parks, Department of Water Resources (DWR), Wildlife Conservation Board (WCB); California Department of Fish and Wildlife (CDFW); Lower Los Angeles Rivers and Mountains (L.A. Rivers & Mountains), State Coastal, San Diego River, Santa Monica Mountains, Sierra Nevada, and Coachella Conservancies
Model used	CALAND Model

FORESTRY

Understory clearing: improved forest health and reduced wildfire severity	
Activity	

Duration of effect	The loss of stored carbon that results from this treatment and the GHG
Implementing agencies	
Model used	CALAND Model
Prescribed burn: improved forest health and reduced wildfire severity	
Activity	
Carbon pool(s) impacted	Above-ground live vegetation, dead biomass
Duration of effect	
Implementing agencies	CAL FIRE, State Parks; Sierra Nevada, Tahoe, San Diego River, and Santa Monica Mountain Conservancies
Model used	CALAND Model
Partial Cut: improved forest health and reduced wildfire severity	
Activity	

	the soil, and 13% and 3% of soil and root biomass decay to the
Carbon pool(s) impacted	Above- and below-ground live vegetation, dead biomass, soil carbon; this also contributes to wood products and/or bioenergy. Modeling assumes that 20% of the harvested biomass goes to durable wood products, 75% goes to energy, and 1% decays rapidly at the sawmill. Additional slash can be removed and utilized for wood products and/or bioenergy (see Increased Forest Biomass Utilization).
Duration of effect	The loss of stored carbon that results from this treatment and the GHG emissions from burning and decay accrue in the year of implementation. This practice enhances net forest carbon accumulation and reduces the fraction of high-severity wildfire for 20 years without additional treatment.
Implementing agencies	CAL FIRE, State Parks, DWR, Sierra Nevada Conservancy
Model used	CALAND Model
Less intensive forest management: enhanced carbon in forested ecosystems	
Activity	This activity entails a change in forest management practices to a less intensive harvest regime, from even-aged management to uneven-aged management (partial cut) or areas of no harvest (reserve areas). It is modeled by moving acreage undergoing even-aged management in the baseline scenario to partial cut in the Alternative scenarios, along with some areas of even-aged and partial cut to no harvest (reserves). Extending harvest rotation period can also be modeled as a reduction in annual harvest area (for either even-aged management or partial cut).
Carbon pool(s) impacted	Above- and below-ground live vegetation, dead biomass, soil carbon, wood products and/or bioenergy
Duration of effect	This is determined primarily by the prescribed scenario. Reducing forest management intensity in a given year likely reduces emissions and/or enhances carbon storage for that year, which may have some persistent effects, but the reduction needs to continue over time to ensure longer-term carbon and GHG benefits. If management intensity increases after a period of lower intensity, the previous benefits may be negated.
Implementing agencies	CAL FIRE, State Parks, State Coastal Conservancy
Model used	CALAND Model
Enhanced Forest Biomass Utilization	
Activity	Increase in the amount (percentage) of slash material diverted to bioenergy and wood products, away from pile burning and decay.
Carbon pool(s) impacted	Wood products

Duration of effect	These are one-time diversions and therefore impacts are one-time and permanent for each year in which increased utilization is implemented. Material diverted to wood products and bioenergy follows the respective storage to decay emission pathways.
Implementing agencies	CAL FIRE; Tahoe, San Diego River, Santa Monica Mountains, and Sierra Nevada Conservancies
Model used	CALAND Model
Reforestation Area Expansion/ Reforestation	
Activity	Establishing forest on shrubland or grassland. Modeled as an increase in forest area. May include reforestation of non-regenerated forest area post-wildfire; this is being assessed in sensitivity analyses.
Carbon pool(s) impacted	Above- and below-ground live vegetation, dead biomass, soil carbon
Duration of effect	
Implementing agencies	CAL FIRE, State Parks, Sierra Nevada Conservancy, WCB, San Diego River Conservancy
Model used	CALAND Model

RESTORATION

Riparian Restoration	
Activity	
Carbon pool(s) impacted	Above- and below-ground tree canopy and understory vegetation, soil carbon
Duration of effect	
Implementing agencies	
Model used	CALAND Model
Oak Woodland Restoration	
Activity	

Duration of effect	Net carbon accumulation rates for woodland begin in the year following
Implementing agencies	State Parks; L.A. Rivers & Mountains, State Coastal, and Santa Monica Mountains Conservancies
Model used	CALAND Model
Coastal Wetland Restoration	
Activity	Creation of saline tidal wetlands on cultivated in coastal regions.
Carbon pool(s) impacted	Above-ground main canopy vegetation, soil carbon
Duration of effect	
Implementing agencies	
Model used	CALAND Model
Delta Managed Fresh Wetland Restoration	
Activity	Conversion of cultivated lands to fresh managed wetlands in the Sacramento-San Joaquin Delta.
Carbon pool(s) impacted	Above-ground main canopy vegetation, soil carbon
Duration of effect	
Implementing agencies	CDFW, DWR, Sacramento San-Joaquin Delta Conservancy, WCB
Model used	CALAND Model
Mountain Meadow Restoration	
Activity	Restoration of meadows in mountain regions. This is modeled as a land type change from shrubland, grassland, and savanna to meadow and

	woodland, which will change carbon dynamics according to the specific
Carbon pool(s) impacted	Above- and below-ground live vegetation, dead biomass, soil carbon
Duration of effect	Net soil carbon accumulation rates for meadow begin in the year following the prescribed implementation year. Any carbon losses and associated GHG emissions accrue in the implementation year. Restored meadow area persists throughout the simulation - area restored does not convert to another land type.
Implementing agencies	CDFW, State Parks, DWR, WCB, Tahoe and Sierra Nevada Conservancies
Model used	CALAND Model
Seagrass Restoration	
Activity	Creation of sub-tidal seagrass beds where none previously existed.
Carbon pool(s) impacted	Above-ground main canopy vegetation, soil carbon (ocean sediment)
Duration of effect	Net sediment carbon accumulation rates for seagrass begin in the year following the prescribed implementation year. Restored seagrass area persists throughout the simulation. In reality, seagrass beds tend to be ephemeral, so the increase of acreage covered by seagrass beds in an Alternative scenario is meant to represent an increase in statewide coverage, above the historical level, rather than consistent establishment at any given locale.
Implementing agencies	Ocean Protection Council, State Coastal Conservancy
Model used	CALAND Model
Urban Forest Expansion	
Activity	Increase in the urban tree canopy above BAU level. This activity is limited to urbanized areas. Modeling includes mortality and disposal of urban trees as well as planting of new trees.
Carbon pool(s) impacted	Main canopy vegetation
Duration of effect	More urban forest area equates to greater net annual carbon accumulation in urban area, with accumulation limited by the prescribed mortality rate. The accrued carbon is retained unless urban area is converted to another land type with lower vegetation carbon density.
Implementing agencies	CAL FIRE, CNRA; L.A. Rivers & Mountains, San Diego River, Santa Monica Mountains, and State Coastal Conservancies
Model used	CALAND Model

AGRICULTURE[22]

Prescribed Grazing[23]	
Activity	
Carbon pool(s) impacted	Soil carbon
Duration of effect	
Implementing agencies	CDFA, State Parks, and State Coastal Conservancy
Model used	COMET-Planner
Silvopasture	
Activity	Planting of shrubs and trees with the purpose of integrating forage and livestock production.
Carbon pool(s) impacted	Woody biomass, soil organic carbon is assumed to remain essentially unchanged.
Duration of effect	
Implementing agencies	CDFA
Model used	COMET-Planner
Hedgerow Establishment	
Activity	
Carbon/nitrogen pool(s) impacted	

[23] See https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1255132.pdf.

	plant residues, and decreased nitrous oxide emissions from synthetic fertilizer.
Duration of effect	Hedgerow practices are maintained for a minimum of 10 years, after which time the carbon accrual benefits are maxed out. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Windbreak Establishment	
Activity	Windbreaks or shelterbelts are single or multiple rows of trees or shrubs planted in linear configurations to increase carbon storage in biomass and soils and reduce soil erosion from wind.
Carbon/nitrogen pool(s) impacted	Woody biomass carbon accumulation, changes in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from synthetic fertilizer. Estimates apply only to the portion of the field where woody plants are established.
Duration of effect	Windbreak establishment practices are maintained for a minimum of 10 years, after which time the carbon accrual benefits are maxed out. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Riaprian forest buffer	
Activity	Riparian Forest Buffer establishment are constructed by replacing conventionally managed and fertilized cropland with unfertilized, woody plants or trees in areas located adjacent to and upgradient from watercourses or water bodies.
Carbon/nitrogen pool(s) impacted	Woody biomass carbon accumulation, change in soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from synthetic fertilizer.
Duration of effect	Riparian forest buffer practices are maintained for a minimum of 10 years, after which time the carbon accrual benefits are maxed out. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Riparian herbaceous cover	

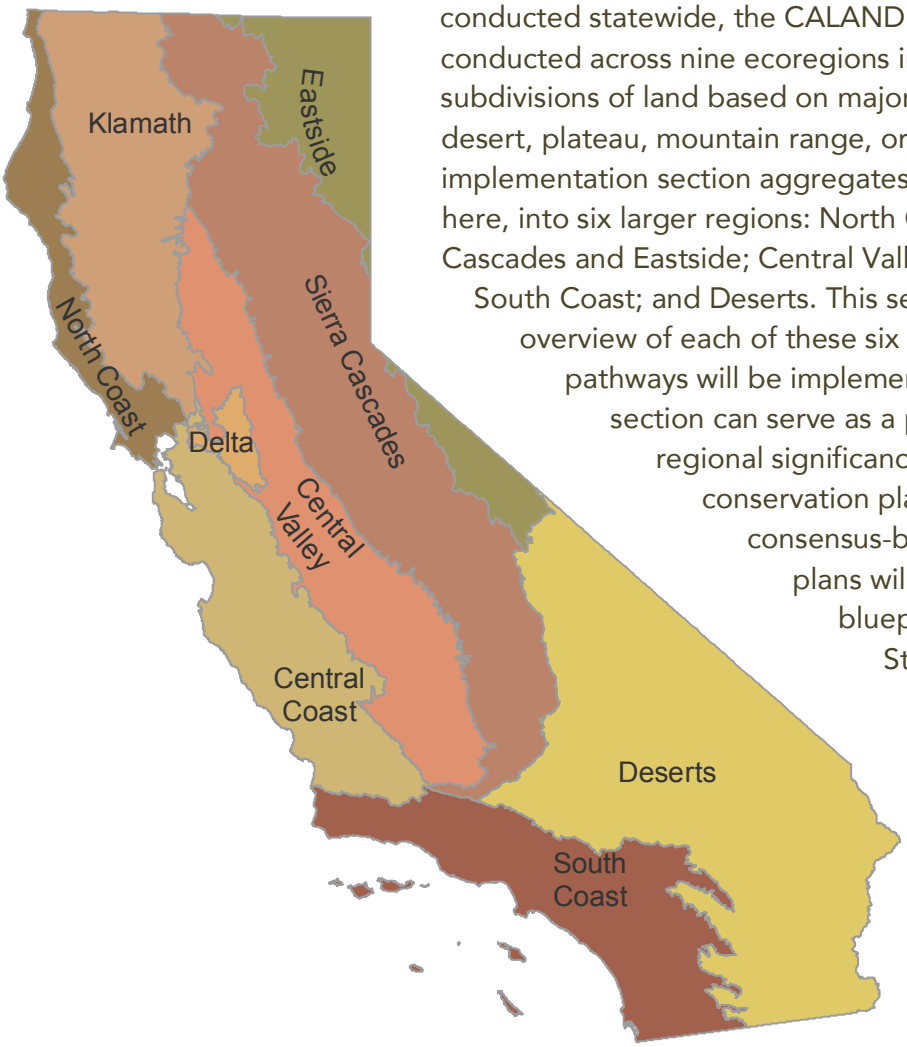
	Herbaceous plants tolerant of intermittent flooding or saturated soils
Carbon/nitrogen pool(s) impacted	Soil organic matter carbon due to cessation of tillage and increased carbon inputs from plant residues, and decreased nitrous oxide emissions from synthetic fertilizer.
Duration of effect	Riparian herbaceous cover practices are annually implemented for 3 years, after which time the carbon accrual benefits are maxed out. The benefits that have accrued remain stored until 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Cover cropping	
Activity	Grasses, legumes, and forbs planted for seasonal vegetative cover. In some instances cover cropping is used for soil nitrogen management.
Carbon pool(s) impacted	Increased carbon inputs from crop residues on soil carbon stocks.
Duration of effect	Cover cropping practices are annually implemented for a minimum of 3 years. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Mulching	
Activity	Addition of high carbon (low nitrogen) organic matter amendments, such as straw or crop residues, to croplands. Growing planned rotations of row crops, forages, small grains, or fallow in a systematic arrangement of equal width strips across a field.
Carbon pool(s) impacted	Addition of organic matter carbon in mulch may increase soil carbon stocks in croplands.
Duration of effect	Mulching practices are annually implemented for a minimum of 3 years. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
No till	
Activity	Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting.

	Soil carbon change from decreased soil disturbance and nitrous oxide
Duration of effect	No till practices are annually implemented for a minimum of 3 years. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Reduced till	
Activity	Managing the amount, orientation and distribution of crop and other plant residue on the soil surface year round while limiting the soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting.
Carbon/nitrogen pool(s) impacted	Soil carbon change from decreased soil disturbance and nitrous oxide emissions from changes in the soil environment (does not include changes in nitrogen fertilizer that may accompany tillage changes).
Duration of effect	Reduced till practices are annually implemented for a minimum of three years. For the purposes of the NWL Implementation Plan, it is assumed that the accrued benefits remain stored through 2045.
Implementing agencies	CDFA
Model used	COMET-Planner
Compost Application	
Activity	Compost is applied to traditionally managed rangeland or cultivated land.
Carbon pool(s) impacted	Soil carbon
Duration of effect	The decrease in annual soil carbon loss is annualized over the specified repeat period, so the scenario prescription needs to include the repeated treatment area at the appropriate interval. At the end of the repeat period the annual benefit ends. This is based on studies showing that the soil carbon benefit of a single compost application diminishes over time, and may eventually disappear over 100 years due to increasing emissions over time.
Implementing agencies	CDFA, State Coastal Conservancy
Model used	COMET-Planner for compost application at CDFA; CALAND Model for compost on rangeland at CNRA

APPENDIX B. ECOREGIONAL IMPLEMENTATION

California's diverse landscapes are characterized by distinct climates and soils and topographic and geographic characteristics, supporting unique biological communities and ecosystem services. As such, the strategies for managing natural and working lands will reflect the regional social and cultural needs of the diverse populations they serve, and implemented on a landscape scale to support multiple benefits. Successful implementation will rely on collaboration with regional partners discussed in **IV., Moving Forward.**

While the COMET modeling analysis to support this Plan was conducted statewide, the CALAND modeling analysis was conducted across nine ecoregions in California. Ecoregions are subdivisions of land based on major terrain features, such as a desert, plateau, mountain range, or a combination thereof. This implementation section aggregates Bailey's ecoregions,[24] depicted here, into six larger regions: North Coast and Klamath-Interior; Sierra Cascades and Eastside; Central Valley and Delta; Central Coast; South Coast; and Deserts. This section provides a high-level overview of each of these six regions. Although almost all pathways will be implemented in almost all regions, this section can serve as a primer on key pathways with regional significance. Importantly, regional land use conservation planning and finer-grained, consensus-based localized implementation plans will provide more detailed blueprints for implementation. The State will work with regional partners to help develop these plans where they do not exist.



California's Ecoregions, based on Bailey's ecoregions

[24] Bailey, R.G. 1976. Ecoregions of the United States (map). USDA Forest Service Intermountain Region, Ogden, UT. Scale 1:7,500.000

NORTH COAST AND KLAMATH INTERIOR COAST

Geography and Climate Impacts:

The North Coast and Klamath-Interior regions extend along the Pacific coast from the North San Francisco Bay Area to the Oregon border, bounded by the Cascade Range to the northeast and the Central Valley to the southeast. Along the North Coast ranges, maritime influences result in a distinct climate and ecosystems. East of the coast, the steep, complex mountainous terrain of the Klamath Ranges traverses the region, harboring some of the most floristically diverse temperate coniferous forests in the world. With Mediterranean climate seasonality, the Klamath Interior region experiences cool, wet winters and prolonged warm, dry summer droughts that support complex vegetation patterns and high floristic diversity.[25] Conifer and mixed hardwood-conifer forests comprise most of the region's land, interspersed by alluvial valleys and riparian forests of the Klamath River system, chaparral and mountain shrub, foothill pasture and agricultural lands, and wetlands. Over a million people live in the region, which includes all or part of thirteen counties. With 37 federally recognized Native American tribes, the region is home to a significant number of tribal and indigenous communities that have resided here for millennia.

Climate impacts to the region include habitat loss for sensitive species, more frequent and severe fire, changes in vegetation types, and reduced productivity of rangeland and pastureland. Sea level rise and increasing risk of flood and landslides pose a threat to coastal ecosystems and infrastructure. The region is expected to see an increased frequency of extreme wet years and extreme dry years, with intense storms associated with atmospheric rivers presenting a substantial flooding risk, especially for the Russian River. Snowpack has diminished significantly in the past several decades, and is expected to decrease dramatically by the end of the century. Increased aridity from snowpack decline will likely exacerbate wildfires, reduce recharge of groundwater basins, and decrease instream flows of the region's rivers and streams.

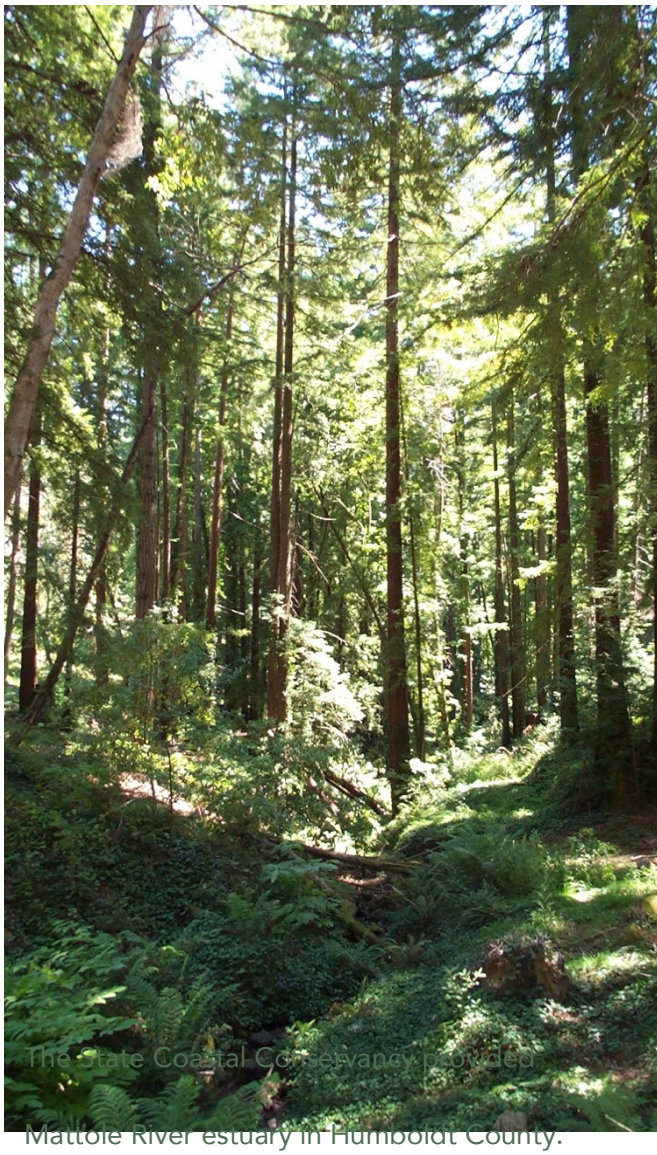
Key Strategies Natural and Working Lands:

- **Riparian restoration agroforestry; Enhanced carbon in forested ecosystems:** The region's legacy of intensive mining and logging has degraded many riverine habitats. Riparian and stream restoration, and increasing buffers of improved forest management around key riverine habitats, could help reduce erosion and protect ecosystems that support high species diversity in the region, including significant populations of Chinook and coho salmon and cutthroat trout. Changes in forest management can increase capacity to sequester carbon, produce sustainably harvested wood, enhance wildlife habitat, protect water supplies, and restore native redwoods and other forests.
- **Land protection:** Working with private landowners to manage lands to protect wildlife, continuing to expand and connect patches of redwood ecosystems and other critical landscapes, and increasing buffers of improved forest management around key

[25]CDFW (2015). State Wildlife Action Plan. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109207&inline

ecosystems could protect carbon stores while helping species adapt to climate change on the North Coast.

- **Improved forest health and reduced wildfire severity; Increased biomass utilization:** Strategies to enhance resilience to pest and disease and reduce stand density in degraded forests, including prescribed fire and thinning, are likely to benefit regional forest health help prevent large losses of carbon. Thinning to improve forest health can be accompanied by increased productive utilization of woody biomass to reduce GHG and black carbon emissions from forest management activities. Diverting thinned material and wood waste from open pile burning to bioenergy, biofuels, and long-lived wood products can reduce emissions from pile burning, offset emissions from fossil fuels, and retain carbon sequestered in downed trees.
- **Wetland restoration:** Rising tides from sea level rise and subsidence could inundate marsh and wetland habitats in areas of the North Coast including the North San Francisco Bay Area and Humboldt Bay. Restoring wetlands and estuaries can help mitigate these climate impacts while improving fish habitat and water quality.



The State Coastal Conservancy provided Mattole River estuary in Humboldt County.

- **Grazing land and grassland management:** A significant portion of agricultural land in the North Coast is used for grazing cattle, sheep, and dairy. To counter predicted reductions in the productivity of rangeland and pasture, especially inland where projected temperatures will be most pronounced, improved management of grasslands through strategies such as compost application and prescribed grazing could also increase carbon sequestration. Carbon benefits of this practice are especially pronounced in the North Coast relative to other regions in California. Grassland fuel management and prescribed burn could help reduce the encroachment of woody plants and invasive plants.
- **Cropland management:** Applying compost, planting cover crops, reducing or eliminating tillage, and planting woody plants, among other strategies, have already been incorporated into many carbon farm plans in the North Coast. Given the importance of grapes and other fruit and vegetable crops to the region's economy, there is a high potential to expand these strategies in the region.

Sierra- Cascades and Eastside

Geography and Climate Impacts:

The Sierra- Cascades and Eastside regions flank the eastern edge of California, extending north from the Mojave Desert to the Oregon border, and bordered by the Central Valley depression to the west. The Sierra Nevada mountain range extends over 440 miles from north to south across the region. The climate consists of cool, wet winters and warm, dry summers. Precipitation varies significantly with latitude, with the southern region snowier than the northern Sierra; and topography, with the westside wetter than the eastside. Vegetation in the region includes oak savannas and chaparral at lower western elevations, mixed conifer and evergreen forests at mid-elevations, desert shrublands and sagebrush on the Eastside and Northeastern sub-regions, and ecologically and hydrologically important montane meadows. Roughly a million people live in the region, which encompasses all or part of 27 counties.

Feather Falls in Plumas National Forest. *Photo: Kelly M. Grow / California Department of Water Resources.*

Climate change impacts including increased wildfire, declining snowpacks, changes in the timing of streamflow, and heat and precipitation extremes are already affecting the region and expected to worsen. Sierra Nevada snowpacks will be reduced by more than 60 percent across the range, with drying soils likely to stress flora and fauna and impact rivers and lakes. Projected changes in climate are associated with large increases in area burned by wildfire and frequency of large fires (burning more than 24,700 acres). A greater likelihood of prolonged drought poses serious risk to forest ecosystems; water stress weakens trees, facilitating bark beetle outbreaks. As of 2017, mortality related to bark beetles and drought had killed 110 million trees in the Sierra, with particularly devastating effects in the southern Sierra.[26]

Key Strategies Natural and Working Lands:

- **Improved forest health and reduced wildfire severity; Increased biomass utilization:** With over half of forestlands in the Sierra in need of treatment, reducing forest densities through prescribed and managed wildfire and thinning is needed to increase forest resiliency to fire hazards, insect outbreaks, and water stress. Thinning to improve forest health can be accompanied by increased productive utilization of woody biomass to

[26] Dettinger, M. et al. (2018). Sierra Nevada Region Report. *California's Fourth Climate Change Assessment.* http://www.climateassessment.ca.gov/regions/docs/20180827-SierraNevada.pdf.

reduce GHG and black carbon emissions from forest management activities. Diverting thinned material and wood waste from open pile burning to bioenergy, biofuels and long-lived wood products can reduce emissions from pile burning, offset emissions from fossil fuels, and retain carbon sequestered in downed trees. However, the lack of infrastructure to process biomass is a significant impediment to forest restoration efforts in the Sierra Nevada. Improving biomass markets could facilitate treatment efforts while providing energy and other resources and creating jobs.

- **Land protection:** The region could benefit from continued conservation efforts that increase habitat connectivity, safeguard climate refugia, and protect foothill woodlands that are under threat for development.
- **Enhanced carbon in forested ecosystems:** Following high severity fire, reforestation with disease-resistant species will help forests recover and prevent type conversion to grassland and shrub. Additionally, because over half of Sierra meadows are known or expected to be degraded, and meadows will be particularly vulnerable to future changes in hydrology, restoring meadows will help safeguard the critical water and biodiversity benefits they provide.
- **Grazing and grassland management:** Managing grazing intensity and timing in oak savanna ecosystems could increase recruitment success and reduce exotic species.

Central Valley and Delta

Geography and Climate Impacts: The Central Valley and Delta ecoregions include most of the low-lying lands that form the lower watershed of a vast hydrological system. While the Sacramento Valley, San Joaquin Valley, and Delta have distinct ecological characteristics, they also share attributes like the dominance of agricultural land uses and rivers with large seasonal flow fluctuations. Annual grassland, valley oaks on floodplains, and arid shrublands dominate unconverted natural habitats in the valley, while the Delta's large estuarine system was once an immense marsh that

has now been extensively diked and drained for flood protection and agriculture. Remaining wetlands and floodplains are crucial to the health of migrating waterfowl and iconic anadromous fish species like salmon. The Delta is critically important to the State's water supply. This region experiences highly variable interannual precipitation, hot and dry summers, and cool, foggy winters.

As the climate continues to change, sea-level rise and shifts in the precipitation mix will threaten ecosystems and populations in the Delta and throughout the Central Valley. Greater rainfall in place of snowpack due to warmer winter temperatures will lead to higher riverine flows. High levels of subsidence in the Delta due to oxidation of peat soils will compound flood risk, and salinity intrusion will also affect agriculture and species. Groundwater extraction has already led to subsidence in the southern Central Valley, where water management will grow more challenging with exacerbated interannual variability and shifting runoff regimes. Rising incidents of extreme heat and observed reductions in fog will increase water stress across the ecoregions, which are extremely vulnerable to extended drought conditions. The changing climate is expected to further stress the limited habitats not converted to agriculture or development.

Key Strategies Natural and Working Lands:

- **Riparian restoration; Agroforestry:** Multi-benefit riparian restoration projects can reduce flood risk and increase water supply while providing critical ecosystem services. Establishing riparian and floodplain vegetation could improve estuarine habitat for fish and waterfowl while improving water quality.
- **Oak woodland restoration:** Restoring oak woodlands, which have been dramatically reduced in extent over the past two centuries, would have large carbon benefits and would augment the biodiversity these woodlands support.
- **Wetland restoration:** Restoring marsh vegetation through Delta wetland restoration can reduce carbon emissions from oxidation of peat soils, and reverse the resulting subsidence that poses a significant risk to California's water supply.
- **Land protection:** Strategically protecting lands will be important in the region given the extensive and continued conversion of habitats and agricultural lands.
- **Grazing land and grassland management:** Improved management of grasslands and rangeland could target increasing carbon sequestration, enhancing resilience to documented climate impacts such as warming, and reducing the spread of invasive species.
- **Cropland management; Compost application:** Crop rotations, tillage systems, cover cropping, and compost application can help conserve soils and improve water efficiency in the face of water shortages in the region. In the Delta, converting subsided and marginal agricultural lands to wetland crops such as rice will help stop land subsidence and reverse it over time.

Central Coast

Geography and Climate Impacts:
The Central Coast ecoregion includes the estuaries, coastal valleys, and coast range mountains spanning from the San Francisco Bay Area to northern Santa Barbara County. Part of California's Mediterranean biome, the Central Coast is a biodiversity hotspot. Sand dunes, wetlands, and coastal scrub and grassland occur along its rugged coasts, with the Coast and Inner Coast ranges running parallel to the coast supporting mixed conifer forests and oak woodlands. Moving inland, its landcover is comprised mostly of grasslands, hardwood forests, scrublands, cultivated croplands, and rangeland. Coastal areas in the region experience lower temperatures and receive higher amounts of annual precipitation, while inland and higher elevation areas experience a greater range of temperatures. The region includes eight counties with 7 million people within the San Francisco Bay Area, and the six coastal counties south with 2.5 million people. These six counties are less densely populated, with intensive agriculture and small-to medium-sized cities composing less than 5 percent of the region's land cover.

As sea levels rise along the Central Coast, beaches will continue to narrow, and marshes may subside or turn to mudflats, leading to a loss of carbon sequestration and other ecosystem services they provide. Estuarine ecosystems will be impacted by sea level rise, ocean acidification, changes in runoff, and increased ocean and air temperatures. The Central Coast's unique climate and soils make year-round agriculture a valuable regional resource, but the Salinas Valley has been identified as one of the agricultural regions most vulnerable to climate change. Saltwater intrusion caused by over-extraction of coastal groundwater wells in the valley could be exacerbated by prolonged droughts and sea level rise. Projected increased and prolonged droughts caused by climate change are expected to seriously challenge the region's already stressed water supplies. A decrease in frequency of the region's characteristic fog could have significant impacts on redwoods and other coastal species.

Key Strategies Natural and Working Lands:

- **Land protection:** Strategically protecting lands will be important in the region given development pressures and projections that significant amounts of grasslands, shrubland, and agriculture could be lost to development in the coming decades.
- **Grazing land and grassland management:** Improved management of grasslands through strategies such as compost application and prescribed grazing could increase carbon sequestration while enhancing their resilience to documented climate impacts such as warming. Fuel management on these lands will also help reduce risk of fire under hotter and drier conditions.

- **Cropland management:** Crop rotations, tillage systems, and cover cropping can help conserve soils and improve water efficiency in the face of water shortages in the region.
- **Wetland restoration:** Restoring coastal wetland ecosystems and their associated flood control benefits will help coastal ecosystems adapt to sea level rise and coastal erosion.
- **Riparian restoration; Agroforestry:** Restoring trees and vegetation near riparian areas could improve stream and estuarine habitat for the spawning and survival of fish and help ameliorate water quality issues.[27]

Resources

Deserts

Geography and Climate Impacts:

The Deserts region encompasses the southeast corner of the State and includes portions of the Mojave, Sonoran, and Great Basin deserts. A rain shadow of the Sierra Nevada, Peninsula, and Transverse mountain ranges that form its northwest border, the ecoregion is the hottest and driest part of the State. Both the cooler Mojave Desert and hotter and lower-elevation Sonoran Desert experience two rainy seasons per year—winter and a late summer monsoon. The region's unique geography and topography make it a biodiversity hotspot that contains 37 percent of California's plant species, many of which are found nowhere else in the State. Flora includes annual grasses, brush, and scrub at lower elevations and juniper, pine, and sagebrush at higher elevations. Major geological features include the Colorado River and Salton Sea. Over one million people live in the region, with population concentrated primarily in the Imperial, Palo Verde, and Coachella Valleys.

[27] Langridge, R. et al. (2018). Central Coast Region Report. *California's Fourth Climate Change Assessment.* http://www.climateassessment.ca.gov/regions/docs/20180928-CentralCoast.pdf

Climate change is making the region's climate more extreme, and daily high temperatures are projected to increase by up to 8-14 degrees Fahrenheit by the end of century. Extreme drought and extreme wet events are both likely to become more common in the region; in turn, these precipitation extremes are predicted to increase the risk of flash flooding and wildfire, with the propagation of invasive grasses greatly increasing fuel loads. High temperatures and climate impacts on the Colorado River will exacerbate existing water stress, with changing water availability likely to impact agriculture and natural systems. Diminishing agricultural flows threaten to shrink the Salton Sea, exposing dry lakebed and releasing dust that harms human health.

Mojave desert wildflowers. *Photo: Genevieve Johnson/ Bureau of Reclamation*

Key Strategies Natural and Working Lands:

- **Land protection**: Strategically protecting biodiversity hotspots will be key to safeguarding unique desert flora and fauna. Suburban sprawl has and continues to fragment and degrade desert landscapes and habitat. Nearly half the total acres of rangeland and agriculture lost statewide in recent decades has occurred within this region,[28] a trend that is expected to continue. Vast amounts of carbon are stored beneath California desert soils and in desert shrublands; this carbon may be lost if these areas are disturbed or stripped of vegetation.[29]
- **Agroforestry; Riparian restoration:** Although desert riparian systems support an abundance of birds and wildlife diversity, around half of the streams and springs in the region are degraded due to overgrazing and human impacts. Reestablishing native plants and tree species such as cottonwood and willows could help reverse degradation of desert riparian plants and soils.

[28] CAL FIRE (2018) http://frap.fire.ca.gov/assessment2017/FinalAssessment2017/Assessment2017.pdf
[29] Allen, M. et al (2013) Carbon Balance in California Deserts: Impacts of Widespread Solar Power Generation. https://www.energy.ca.gov/2014publications/CEC-500-2014-063/CEC-500-2014-063.pdf

- **Grazing land and grassland management:** Historically, overgrazing has contributed to the spread of cheatgrass and other invasive annual grasses. Strategies are now needed to manage invasive species on grazing land and grassland, since weeds and the fires they fuel are particularly problematic.
- **Urban forestry and urban greening:** The increased use of urban vegetation in the region could help provide a buffer against higher maximum temperatures and could help capture and recycle stormwater.
- **Cropland management:** The annual agriculture output California's three desert counties – Riverside, San Bernardino, and Imperial – exceeds $4 billion. Crop rotations, tillage systems, cover cropping, and compost application could help conserve soils and improve water efficiency for agriculture in the region.

South Coast

Geography and Climate Impacts:
The South Coast ecoregion extends from Santa Barbara County to the Mexican border in the south, bounded by the Pacific Ocean to the west and arid mountains to the east. Its extensive urban areas are surrounded by varied landscapes, ranging from wetlands and beaches to rugged mountains and deserts. It is considered a biodiversity hotspot with more than 470 animal species, with over 150 of those listed as protected or considered sensitive. This region has the largest population and is home to over a quarter of the State's residents. The South Coast's many people and species enjoy a temperate semi-arid Mediterranean climate across its coastal plains, though inland areas grow increasingly arid and hot. Many river corridors in urban areas have been channelized, leading to the loss of native species. Most of the South Coast's once extensive wetlands have been converted or degraded, and sage scrub, chaparral, and forested communities have also experienced development pressures.

Rising sea levels, in tandem with greater erosion, pose threats to beaches and remaining coastal wetlands, with one study finding that two-thirds of the region's beaches could disappear by the end of the century.[30] This area also experiences the greatest risk of fire threat in the State, with 26 percent of land under extreme fire threat and 51 percent of land under very high fire threat according to CAL FIRE."[31] Climate change will exacerbate these risks, with the fire season expected to lengthen and fire frequency anticipated to increase. Hotter and more arid conditions are also expected to accelerate conversion of shrubland and other land covers to non-native grasslands and deserts. In cities, higher temperatures will exacerbate urban heat island effects and decrease air quality by increasing the production of pollutants

[30] Erikson, L.H. et al. (2018). Assessing and Communicating the Impacts of Climate Change on the Southern California Coast. *California's Fourth Climate Change Assessment.* http://www.climateassessment.ca.gov/techreports/docs/20180827-Ocean_CCCA4-CNRA-2018-013.pdf
[31] CAL FIRE (2017). http://frap.fire.ca.gov/assessment2017/FinalAssessment2017/Assessment2017.pdf

such as ozone. Ocean acidification and hypoxia also pose threats to coastal species, with warmer water temperatures also linked to harmful algal blooms.

Key Strategies Natural and Working Lands:

- **Wetland restoration:** Restoring coastal wetlands and implementing green infrastructure shoreline protection solutions will help coastal ecosystems adapt to sea level rise and coastal erosion.
- **Improved forest health and reduced wildfire severity**: Reducing severity of forest, chaparral, and grassland fires will be critical for resilience and to avoid largescale type conversion to lower carbon systems.
- **Urban forestry:** Natural solutions to projected rises in extreme heat events can mitigate public health risks and provide co-benefits to the region's many disadvantaged communities. Expanding the tree canopy will help cool urban areas and filter pollutants.
- **Riparian restoration:** The region's degraded riparian corridors offer substantial potential for achieving ecosystem, recreation, and water quality benefits.
- **Land conservation:** Preserving land in the South Coast ecoregion will help increase access to parklands and open space for recreation, provide connectivity for wildlife, and encourage infill development.
- **Cropland management:** Crop rotations, tillage systems, and cover cropping, and other practices will help conserve soils and improve water efficiency in the region, which produces significant quantities of berries, fruits, and vegetables.

Photo: San Diego River Conservancy

APPENDIX C: CALIFORNIA NATURAL RESOURCES AGENCY BOARD, DEPARTMENT, AND CONSERVANCY IMPLEMENTATION DESCRIPTIONS

This section describes programs and projects that restore, manage, and conserve natural and working lands that may be leveraged or replicated to achieve the goals for the California Natural Resources Agency (CNRA) described in this Plan. These programs are implemented by the following boards, departments, and conservancies within CNRA:

Boards and Departments-

- California Natural Resources Agency's Bonds and Grants Division
- California Department of Conservation
- California Department of Fish and Wildlife
- California Department of Forestry and Fire Protection
- California Department of Parks and Recreation
- California Department of Water Resources
- California Wildlife Conservation Board

Conservancies-

- California Tahoe Conservancy
- Sacramento San-Joaquin Delta Conservancy
- San Diego River Conservancy
- San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy
- Santa Monica Mountains Conservancy
- Sierra Nevada Conservancy
- State Coastal Conservancy

California Natural Resources Agency's Bonds and Grants Division

The California Natural Resources Agency's mission is to restore, protect and manage the State's natural, historical and cultural resources for current and future generations using creative approaches and solutions based on science, collaboration and respect for all communities and interests involved.

The California Natural Resources Agency (CNRA) develops policy and distributes grants for projects that conserve and restore resources, sequester carbon, reduce GHGs, enhance habitat, and make California's communities, environment, and infrastructure more resilient to climate change.

Urban Greening

Strategies: Urban forestry and urban greening

The CNRA Urban Greening Program funds projects that reduce GHG emissions by sequestering carbon, decreasing energy consumption, and reducing vehicle miles traveled. The Program emphasizes carbon sequestration and the mitigation of GHG emissions through projects that expand the urban tree canopy by planting trees and develop low-carbon means of transportation through bicycle paths and lanes or pedestrian facilities. Expanding the urban tree canopy not only increases carbon sequestration directly, but also helps urban communities adapt to the adverse effects of climate change by providing shade to the public, reducing energy costs associated with cooling, and filtering air pollutants and stormwater runoff. A minimum of 75% of available project funding are allocated to projects located within, and providing benefits to, disadvantaged and low-income communities. This demonstrates the State's commitment to ensuring all residents, particularly those that tend to have the least resources available for adapting to climate change and are disproportionately burdened by climate impacts, are receiving the support they need to build resilient communities.

Environmental Enhancement and Mitigation Program

Strategies: Urban forestry and urban greening; Land protection; Riparian, Oak Woodland, and Chaparral Restoration

EEM Chaparral lands restoration

CNRA's Environmental Enhancement and Mitigation (EEM) Program provides funding for projects that contribute to mitigation of the environmental impacts of transportation facilities. Grants are competitively awarded for projects to plant trees and other vegetation or for the acquisition, restoration, and enhancement of resource lands to help mitigate impacts to the State's resource lands by transportation facilities. Projects are most competitive that provide multiple benefits to help California decrease air and water pollution, reduce consumption of natural resources and energy, increase reliability of local water supplies, and increase resilience to climate change. Examples of eligible activities include enhancing and expanding urban forest, local parks, and open space; greening of existing public lands and structures, including school campuses; capturing, storing or infiltrating stormwater for ground water recharge; restoring and expanding floodplains; landscaping for heat island mitigation and energy conservation; and preserving and protecting agricultural land, open space, wetlands, and other natural areas in perpetuity through land acquisitions. While climate change continues to

challenge the stability of California's resources, the EEM program exemplifies resources stewardship that will help bolster the natural environment and mitigate future climate impacts.

Related programs:

- *River Parkways Program:* This program supports parkways projects such as trails and parks, creek restoration, and low-impact flood management projects that provide public access along rivers, streams, creeks.
- *Cultural, Community, and Natural Resources Program:* This grant program will fund a wide range of projects including those which enhance park, water, and natural resource values through improved recreation, tourism, and natural resource investments in areas of the State not within the jurisdiction of a State conservancy.
- *Urban Greening Infrastructure Program*: A variety of green infrastructure projects such as green streets, tree planting, parks, and commuter trails will be supported through this program.
- *Urban Stormwater and Waterways Improvement Program*: This program will fund projects that promote stormwater capture and storage or reduce stormwater pollution.

California Department of Conservation

The Department of Conservation's mission is to balance today's needs with tomorrow's challenges and fosters intelligent, sustainable, and efficient use of California's energy, land, and mineral resources.

The Department offers multiple programs to support the conservation of working lands and promote orderly growth and development, including the Sustainable Agricultural Lands Conservation Program.

Sustainable Agricultural Lands Conservation Program

Strategies: Land protection

The Sustainable Agricultural Lands Conservation Program offers competitive grants to permanently protect important agricultural lands under threat of conversion through the acquisition of permanent voluntary agricultural conservation easements. The program also offers funding to design and implement local or regional agricultural land conservation strategies that reduce GHG emissions through the long-term protection of agricultural lands under threat of conversion. This program advances California's climate goals by supporting infill development and avoiding increases in GHG emissions associated with the conversion of California's agricultural lands to other uses, particularly low-density residential development. Protecting critical agricultural lands from conversion promotes smart growth, supports a healthy agricultural economy, protects food security, and keeps open space available for future generations. Since its inception in 2014, the program has invested $124 million in agricultural conservation to protect 91,000 acres, avoiding 45.2 MMT CO2e. This program also complements California's existing farmland conservation efforts, including the Williamson Act, the California Farmland Conservancy Program, and local and regional agricultural conservation policies throughout California.

Silacci Ranch Conservation Easement Project

Strategies: Land protection

Silacci Ranch, Monterey County CA. Photo: Michael Shaw

The Silacci Ranch conservation easement, funded by the Sustainable Agricultural Lands Conservation Program in 2017, will permanently protect over 9,400 acres of important farmlands and grazing lands along the eastern edge of the City of Salinas' Sphere of Influence. The property, which has been owned by the same family for over 130 years, neighbors an 11,900-acre ranch, also protected by conservation easement. Permanently protecting Silacci Ranch will help to establish a greenbelt that extends from the eastern Salinas Valley to the ridgeline of the Gabilan Range. This greenbelt will support infill development in the City of Salinas, helping California meet its climate goals by avoiding vehicle miles traveled and associated increases in GHG emissions.

The conservation easement is divided into two zones: 318 acres of irrigated farmland and over 9,100 acres of grazing land. The landowners seasonally graze 450 cow/calf pairs on the rangeland portions and lease the remaining irrigated parcels to berry and lettuce growers year-round. The ranch is located in a climatic transition zone, supporting oak woodlands and riparian corridors that provide habitat for special-status species including the kit fox, California tiger salamander, California red-legged frog, bald eagle, and tricolored blackbird. Additionally, it is in close proximity to Pinnacles National Park, creating habitat connectivity and wildlife corridors. The applicant is also partnering with other funders to ensure long-term management of the property that is compatible with the Santa Cruz Mountains Linkages Conceptual Area Protection Plan and that will protect the agricultural and ecological values on the property.

Related programs:

- *California Farmland Conservancy Program*: This program provides funding to permanently shield the State's best and most vulnerable agricultural land from development. Since its inception in 1996, the program has protected over 49,300 acres.
- *Agricultural Land Mitigation Program*: Administered on behalf of the California High-Speed Rail Authority, this program establishes permanent agricultural conservation easements on land of similar acreage, location, and quality to that impacted by the rail project's alignment and maintenance facilities, compensating for the loss of 2,500 acres of Important Farmland resulting from construction from San Jose to Bakersfield.
- *Williamson Act Program:* Also known as the California Land Conservation Act of 1965, this program enables local governments to enter into contracts with private landowners for restricting specific parcels of land to agricultural or related open space use, in return for a substantially reduced property tax assessment.
- *Farmland Mapping and Monitoring Program:* This program produces maps and statistical data used for analyzing impacts on California's agricultural resources.
- *Resource Conservation District Assistance Program:* The Department of Conservation provides financial and technical assistance to California's Resource Conservation Districts

(RCDs) in their mission to develop a land stewardship ethic that promotes long-term sustainability of the State's rich and diverse natural resource heritage.

- *Forest Health Watershed Coordinator Grant Program:* This program funds watershed coordinator positions to develop and implement watershed improvement plans consistent with the California Forest Carbon Plan and Executive Order B-52-18. Watershed coordinators facilitate watershed-scale collaborations, promote integrated watershed management efforts, and support local implementation activities to restore resilience to forestlands.
- *Proposition 68 grant programs:* The Department of Conservation received funding through the recent Parks, Recreation, and Water Bond to protect, restore, or enhance working lands and riparian corridors through conservation easements or other conservation actions, and for watershed restoration and conservation projects on agricultural lands.

California Department of Fish and Wildlife

California Department of Fish and Wildlife's mission is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.

The California Department of Fish and Wildlife (CDFW) administers multiple grant programs that fund habitat restoration projects including meadow restoration, riparian reforestation, wetland restoration, and implementation of ecologically sound forest management practices to reduce greenhouse gas emissions and stabilize carbon storage while promoting climate resilience and providing other ecological benefits.

Watershed Restoration Grant Programs

Strategies: Improved forest health and reduced fire severity; Grazing land and grassland management; Wetland Restoration; Land protection

CDFW's Watershed Restoration Grant Programs administer multiple grant programs that fund projects that reduce GHG emissions by sequestering carbon while providing climate adaption and resilience. CDFW selects projects that provide climate change adaptation for target ecosystems or species through decreasing climate change exposure or sensitivity or increasing adaptive capacity.

The Wetlands Restoration for Greenhouse Gas Reduction Program administers a portion of the Greenhouse Gas Reduction Funds to implement projects that restore mountain meadows, coastal tidal wetlands, and Sacramento-San-Joaquin Delta wetlands to reduce greenhouse gas emissions, and sequester carbon. The Department's Proposition 1 and Proposition 68 Grant Programs fund projects that implement the California Water Action Plan. These programs focus on projects in coastal and wetlands, rivers and streams, mountain meadows, forested headwaters, and large-scale wildlife recovery response and prevention. The Fisheries Restoration Grant Program funds planning

and implementation of instream, riparian, and watershed projects that support salmon and steelhead recovery. These programs provide multiple benefits such as decreased air pollution, improved conditions for native species, improved water quality, sea-level rise and inland flooding adaptation, subsidence reversal, and increased recreation opportunities.

Restoration of the Carbon Storing Ecosystem in Tuolumne Meadows, Yosemite National Park, California. Photo: Daniel Burmester

Related programs: several additional CDFW efforts support programs, projects, initiatives, or partnerships that promote the reduction of GHG emissions, carbon sequestration, and increase the adaptive capacity California's fish and wildlife including:

- *California State Wildlife Action Plan*: The State Wildlife Action Plan is a comprehensive statewide assessment that incorporates climate change impacts and adaptation strategies to provide a prioritized set of conservation strategies and goals intended to guide resource management actions.
- *Areas of Conservation Emphasis (ACE)*: ACE is a data-driven mapping and modeling effort that summarizes information about biodiversity, habitat importance, habitat connectivity, and climate resilience to help prioritize conservation efforts across the state.
- *Science Institute – Climate Program*: The climate program supports Department efforts to address the impacts of climate change on fish, wildlife, and plants by enhancing communication around this issue and developing materials and trainings for staff related to climate risks and adaptation.
- *Vulnerability assessments*: Vulnerability assessments determine which fish, wildlife, and plant species may be most vulnerable to climate change, and why. These assessments provide crucial information for conservation and adaptation planning.

California Department of Forestry and Fire Protection

The Department of Forestry and Fire Protection serves and safeguards the people and protects the property and resources of California.

CAL FIRE is responsible for regulating working timberlands and to encourage stewardship of California's forest and woodlands. Through its grant and cost-share programs, CAL FIRE invests in projects that:

1) Manage our forests for long-term storage of carbon in trees and soils;

2) Conserve our forests so that they may continue to provide for sustainable activities including timber production; and
3) Implement activities in our forest and at the wildland-urban that help minimize the loss of forest carbon from large, intense wildfires.

Together, these programs help achieve the goals of the Forest Carbon Plan, California's Natural and Working Lands Climate Change Implementation Plan, and California's long-term climate goals.

Fire Prevention Grant Program

Strategies: Improved forest health and reduced wildfire severity

CAL FIRE's Fire Prevention Program funds local organizations to implement activities that aim to reduce the risk of wildland fires to habitable structures and communities, while maximizing carbon sequestration in healthy wildland habitat and minimizing the uncontrolled release of emissions emitted by wildfires. The large, catastrophic wildfires that we are experiencing in our state create significant carbon releases that counter California's efforts at reducing GHGs. Local projects funded by the Fire Prevention Program aim to prevent wildfires before they start, and when combined with other fuels treatment and fire management activities, contribute toward the State's long-term GHG reduction goals. Funded activities include hazardous fuel reduction, fire prevention planning, and fire prevention education that also greatly benefit public health and safety.

Forest Health Grant Program

Strategies: Improved forest health and reduced wildfire severity; Enhanced carbon in forested ecosystems; Increased biomass utilization; Land protection

CAL FIRE's Forest Health program distributes grants to non-profits and local and state resource agencies to implement collaborative projects that extend across multiple land ownerships with the goal of creating resiliency in California's forests. A resilient forest will be better able to absorb the impacts of disturbances caused by a fire, forest pests, and drought, and return to a prosperous state following these disturbances. Forest Health projects focus on increasing forest fuels reduction, managing forest pests, and conserving (through easements and acquisitions) those lands threatened with conversion to non-forest uses. Multiple funding projects include a bioenergy component—turning trees killed by drought and bark beetles into energy. All projects have calculated climate benefits that account for reduced GHG emissions from treatment activities, avoided future wildfire and fossil fuel use, and/or sequestering carbon through reforestation or increased growth and yield of remaining vegetation. Forest Health projects also provide additional socio-economic and public health benefits, and often contribute to improved air and water quality, fish and wildlife habitat, and native plant and other environmental values.

California Forest Legacy Program

Strategies: Improved forest health and reduced wildfire severity; Enhanced carbon in forested ecosystems; Increased biomass utilization; Land protection

Under this competitive grant program, CAL FIRE purchases or accepts donations of conservation easements or fee title of productive forest lands that are threatened with conversion to non-forest uses. The lands continue to provide economic value through sustainable activities including timber production and livestock grazing. Protection of California's forests through this program ensures they continue to provide economic benefits from sustainable timber production and valuable co-

benefits such as wildlife habitat, recreation opportunities, watershed protection and open space. Intact forests also contribute significantly to the storage and sequestration of carbon.

California Forest Improvement Program

Strategies: Improved forest health and reduced wildfire severity; Increased biomass utilization; Land protection

The California Forest Improvement Program (CFIP) to encourages private and public investment in, and improved management of, California forest lands and resources. Cost-share assistance is provided to private and public ownerships containing 20 to 5,000 acres of forest land for activities such as land management planning, site preparation, tree purchase and planting, timber stand improvement, fish and wildlife habitat improvement, and land conservation practices. The objective is to ensure adequate high quality timber supplies, related employment and other economic benefits, and the protection, maintenance, and enhancement of a productive and stable forest resource system for the benefit of present and future generations.

Vegetation Management Program

Strategies: Improved forest health and reduced wildfire severity

The Vegetation Management Program (VMP) is a cost-sharing program that focuses on the use of prescribed fire and some mechanical means for addressing wildland fire fuel hazards and other resource management issues on State Responsibility Area (SRA) lands. The use of prescribed fire mimics natural processes, restores fire to its historic role in wildland ecosystems, and provides significant fire hazard reduction benefits that enhance public and firefighter safety. VMP allows private landowners to enter into a contract with CAL FIRE to use prescribed fire to accomplish a combination of fire protection and resource management objectives, including reduction of conflagration fires, optimization of soil and water productivity, protection and improvement of fish and wildlife habitat, increased public safety, and improved water quantity.

CAL FIRE Firefighters providing critical fuel reduction by chipping and removing bark beetle infested trees in Fresno County.

Related programs: CAL FIRE's Urban and Community Forestry Program works to expand and improve the urban tree canopy in California's communities.

California Department of Parks and Recreation

The Department of Parks and Recreation's Mission is to provide for the health, inspiration and education of the people of California by helping to preserve the state's extraordinary biological diversity, protecting its most valued natural and cultural resources, and creating opportunities for high-quality outdoor recreation.

Malibu Lagoon Restoration and Enhancement Project at Malibu Lagoon State Beach

Strategies: wetland restoration

This project, located west of the main channel of Malibu Creek, was filled in the 1920s with materials from construction of Roosevelt (now Pacific Coast) Highway. The California Department of Parks and Recreation (State Parks) acquired the property in the 1970s and completed a General Development Plan for the unit in 1978. At the time, the site was occupied by non-native vegetation and ponded areas that attracted mosquitoes; the Plan identified the need to grade the area to increase marsh habitat and drain the ponded water to the creek. In 1983 State Parks completed a project that graded three channels and installed a beach access path with bridges through the site. While this initial restoration increased wetland habitat, sediment began to accumulate in the created channels. The system was highly eutrophic with extremely high levels of biologically available nutrients, low dissolved oxygen, and elevated water temperatures. Malibu Creek and Lagoon were on the Clean Water Act's 303 (d) list of impaired waterways.

Malibu Lagoon

In 2000, State Parks convened a Lagoon Task Force composed of local stakeholders to identify restoration options for the lower Malibu Creek Watershed. The highest priority identified by the task force was a reconfiguration of the western channels of the lagoon in order to increase circulation and improve ecological function. A feasibility study was completed and, with the assistance of a scientific advisory panel, a project plan was developed. Project goals were to improve water quality and circulation under all hydrologic conditions, improve storm flow and tidal sediment discharge, reduce sediment nutrient content, increase grain size, and improve ecological sustainability through the creation of an optimum three dimensional lagoon geometry.

During Phase One of the project's implementation (2008), the existing asphalt parking lot was demolished and replaced with a crushed shale permeable lot relocated closer to the highway, freeing space for the reclamation of two acres of additional wetland habitat. The new parking lot drains into native plant bio-swales capable of infiltrating and treating up to three inches of rain in a 24-hour period, significantly reducing storm water volume and urban pollutant loading into Malibu Lagoon. During Phase Two (2012-2013), the existing channels were reconfigured into a wider single branched channel oriented toward the incoming tide to allow for more scouring of impounded nitrogen-laden sediments. Site elevation was lowered with the removal of fine-grained accumulated sediments and several feet of fill. New islands were oriented east-west to align with the prevailing wind, providing greater oxygenation of the water. The pedestrian path that had

further impaired circulation was relocated to the perimeter of the site. Five interpretive areas were constructed to allow for close observation of the lagoon and its fauna by park visitors.

Related programs:

- *Redwood Rising:* California State Parks teamed up with Save the Redwoods League and the National Partnership to bring back redwoods on 40,000 acres of public lands in Redwood National and State Parks, accelerate the pace of redwood forest recovery, and to protect remaining old-growth groves in California's North Coast.
- *Statewide Park Development and Community Revitalization Program:* Through Proposition 68, California State Parks received to create new parks and recreation opportunities in critically underserved communities across California. $254,942,000 will be awarded in winter 2018 for Round 3 of the Program.
- *Urban Greening – Los Angeles State Historic Park:* On April 22, 2017, California State Parks celebrated the grand opening of the Los Angeles State Historic Park which currently provides recreational and educational opportunities for visitors. The park unit creates 32 acres of open space with walkways and views in the heart of Los Angeles.
- *Landscape-scale restoration projects:* California State Parks is beginning to manage natural and cultural resources as geographically larger interconnected landscapes. The landscape approach to management considers the varied interaction of people and nature to understand historic land use and adaptation, to inform land managers about future human behavior.

California Department of Water Resources

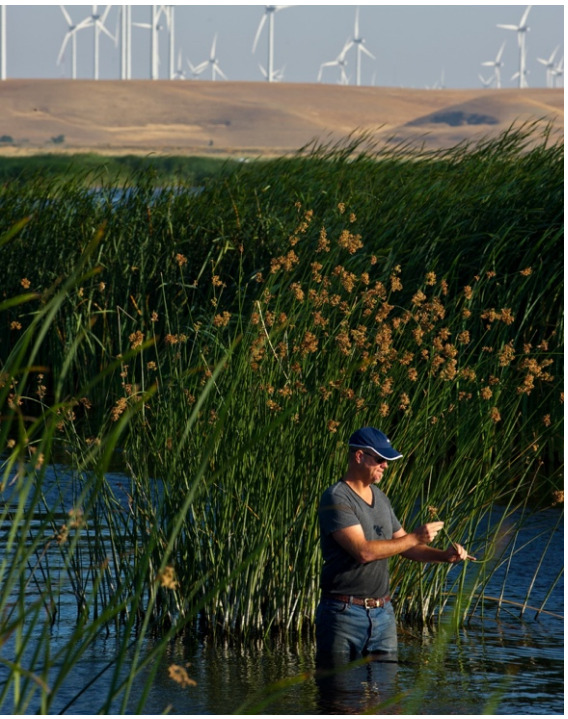
The Department of Water Resources (DWR) is responsible for managing and protecting California's water resources.

DWR works with other agencies to benefit the State's people and to protect, restore, and enhance the natural and human environments.

West Delta Program

Strategies: Wetland restoration; Cropland management

The West Sacramento San-Joaquin Delta is a vital region that protects against migration of salt water, ensuring water quality for upstream uses (including potable and agricultural water uses). The West Delta also provides habitat for plants and wildlife in a geographical area with a rapidly growing population. Because of the peat soils in the West Delta and land management practices such as farming that have promoted oxidation of the peat soils over the years, land subsidence has been occurring at rapid rates. Subsidence jeopardizes levee stability and creates a larger void for saltwater penetration in the event of a levee breach. The Department of Water Resources purchased much of the land on two West Delta islands – Sherman Island (approximately



Measuring carbon uptake on Sherman island wetlands. Photo: California Department of Water Resources.

90% of the island) and Twitchell Island (approximately 80% of the island)— in the early 1990s to protect levees, ensure water quality, and create habitat.

Research shows that utilizing certain types of plants and implementing specific land use management practices will not only limit or reduce the oxidation of peat and land subsidence, but also could sequester atmospheric carbon and/or other GHGs. Because of this potential benefit, carbon sequestration should be a key consideration when evaluating potential land use practices. DWR has implemented large-scale efforts to develop sustainable practices that sequester carbon and reduce subsidence, while also supporting wildlife habitat on Sherman and Twitchell Islands. DWR works closely with stakeholders to develop specific and collaborative projects to achieve these goals. Completed projects include the Twitchell Island East End Wetland Restoration Project, which restored approximately 740 acres of wetlands and 50 acres of riparian forest habitat on Twitchell Island. Another project, the Sherman Island-Belly Wetland restoration Project, restored 1,500 acres of wetlands on Sherman Island.

Related programs:

- *Riverine Stewardship Program:* This program delivers technical and financial assistance for the protection of listed fish species in combination with flood risk reduction and ecosystem enhancement of urban streams.
- *Suisun Marsh Habitat Management, Preservation, and Restoration Plan:* This Plan, finalized in 2014 through a partnership between Bureau of Reclamation, USFWS, CDFW, and DWR, calls for 5,000 to 7,000 acres of tidal restoration and 40,000 to 50,000 acres of managed wetland enhancement to benefit wintering and breeding waterfowl. The goal of the plan is to achieve an acceptable multi-stakeholder approach to the restoration of tidal wetlands and the enhancement of managed wetlands and provide a regulatory framework for operations and maintenance activities on private and public land.

California Wildlife Conservation Board

The Wildlife Conservation Board protects, restores and enhances California's spectacular natural resources for wildlife and for the public's use and enjoyment in partnership with conservation groups, government agencies and the people of California.

The California legislature created the Wildlife Conservation Board (WCB) in 1947 to conserve California's wildlife resources and provide for suitable public recreation. In addition to fulfilling its original purposes, WCB is now also responsible for implementing a variety of legislative and voter-

approved conservation programs statewide. WCB awards grants to other State, federal and local entities and non-profit organizations, and also acquires lands and property interests on behalf of the CDFW to protect wildlife habitats. WCB programs fund critical work of conservation partners throughout California, and focus primarily on acquisition of lands to conserve wildlife habitats (fee title and conservation easements), wildlife habitat restoration and enhancement, and development of wildlife-oriented public access facilities.

Everything WCB funds is focused on long-term protection and resilience. Land acquisition, both fee title and conservation easements, are protected in perpetuity. Habitat restoration and enhancement projects are implemented with the requirement that they be managed and maintained well into the future, typically of 25 years or more, but all have self-sustaining habitats that will persist long after the active management is complete. These projects are evaluated with an eye to assuring that the habitats conserved will provide wildlife benefits no matter how the climate is predicted to change. One land acquisition, and two habitat restoration projects, described below, provide a broad overview of climate mitigation activities that are commonly implemented in WCB's programs.

Indian Creek restoration

Indian Creek, Lost Coast Redwood, and Salmon Initiative Phase II

Strategies: Enhanced carbon in forested ecosystems; Riparian restoration; Land protection

Indian Creek, protected with a conservation easement over more than 2,700 acres, is large and biologically diverse enough to provide substantial long-term benefits for a suite of wildlife species on its own. In addition, it connects protected lands owned by State Parks and CDFW with nearly 50,000 acres of protected privately owned forest lands. The conservation easement will prevent future subdivision and limit any development of the property that might have a detrimental effect on the watersheds and ecological benefits of the property. It prohibits even-aged management, protects old-growth trees, widens riparian buffers, and creates specially-protected Late Seral Reserves where no commercial logging will be conducted. Finally, a primary goal of the easement is to permanently limit dry-season water withdrawals from surface watercourses on the property in order to improve ground and surface water hydrology and summer stream flows within and downstream for the benefit of wildlife, fish, including chinook and coho salmon and steelhead trout, and neighboring communities.

Sears Point Wetland Restoration

Strategies: Wetland restoration; Riparian restoration

Sears Point Wetland Restoration, is a 955-acre tidal marsh restoration that lies within a protected landscape of more than 2,300 acres. The entire property extends deeply into the surrounding uplands, reaching elevations of nearly 400 feet. The property contains grasslands, willow groves, seasonal wetlands and nearly nine miles of riparian corridor. The property lies adjacent to San

Pablo Bay, which is rich in sediments, providing processes that will allow the restored tidal wetlands to rise to match projected sea level rise.

Davis Ranch

Strategies: Riparian restoration; Agroforestry; Grazing land and grassland management

Davis Ranch is a 5,300-acre privately owned ranch with its eastern boundary lying immediately adjacent to the Sacramento River and abutting the Colusa National Wildlife Refuge to the west. Approximately one mile of the historic Sycamore Slough, once a major tributary to the Sacramento River that has since been mainly converted to agricultural uses, runs through the southeast portion of the Ranch. The project restored riparian habitat on Sycamore Slough, reconnecting it to the Sacramento River. In addition, approximately 4.5 miles of hedgerows and riparian habitats were constructed to make an uninterrupted connection between the Sacramento River and the Colusa National Wildlife Refuge. In all, approximately 18 acres of woody habitats were restored.

Related programs: All WCB programs, listed below, support climate mitigation through forest management, meadow, grassland, and woodland restoration, and land conservation:

- *Conservation:* Acquisition Program; Rangeland, Grazing Land and Grassland Protection Program
- *Restoration, preservation, and protection:* Ecosystem Restoration on Agricultural Lands Program; Climate Adaptation and Resiliency Program; Habitat Enhancement and Restoration Program; Stream Flow Enhancement Program; California Riparian Habitat Conservation Program; Inland Wetlands Conservation Program; Forest Conservation Program; Oak Woodland Conservation Program

California Tahoe Conservancy

The mission of the California Tahoe Conservancy (Conservancy) is to lead California's efforts to restore and enhance the extraordinary natural and recreational resources of the Lake Tahoe Basin.

The Conservancy manages more than 4,600 parcels in the Lake Tahoe Basin (Basin) totaling over 6,500 acres, creating a vast network of public lands that provide open space, support wildlife, and reduce runoff that impairs Lake Tahoe's famed clarity. It acquires and funds the development of public beaches and parks and operates a land bank to acquire and sell development rights. Finally, through grant programs and initiatives the Conservancy leads conservation and recreation projects as part of the State of California's contribution to the multijurisdictional Lake Tahoe Basin Environmental Improvement Program.

Lake Tahoe West Restoration Partnership

Strategies: Improved forest health and reduced wildfire severity, Enhanced carbon in forested ecosystems; Riparian restoration

The goal of Lake Tahoe West— an interagency initiative of the California Tahoe Conservancy, U.S. Forest Service Lake Tahoe Basin Management Unit, California State Parks, Tahoe Regional Planning Agency, Tahoe Fire and Fuels Team, and National Forest Foundation— is to restore the resilience of the west shore's forests, watersheds, recreational opportunities, and communities to threats such as wildfire, persistent drought, changing climatic conditions, and a potential bark beetle epidemic. The planning area includes 60,000 acres of federal, state, local, and private lands. Partners and stakeholders recently completed a Landscape Resilience Assessment which analyzed resource conditions and identified the parts of the landscape that are most vulnerable to changing climate and other disturbances. The assessment is guiding a Landscape Restoration Strategy which will outline management actions that build ecosystem resilience, increase restoration byproduct utilization, and sequester and store carbon sustainably.

Photo: Eric Prado

Lake Tahoe Basin Climate Adaptation Action Plan

Strategies: Land protection, Enhanced carbon in forested ecosystems; Riparian restoration

Along with state, federal, non-profit, and business partners, the Conservancy is collaboratively developing an interagency Climate Adaptation Action Plan (CAAP) for the Lake Tahoe Basin. Climate change poses a major threat to the Lake Tahoe Basin. From the famed clarity of Lake Tahoe, to world-class winter snow resorts, to enjoyment of hiking and biking and everything in between. The CAAP will inform climate-smart action: synthesize the growing scientific literature on the potential impacts of climate change on the Basin; identify the natural resources, communities, and infrastructure most at risk; and, provide a framework for integrating climate resilience into the Basin's planning and investment programs.

Related programs:

- *Land Management and Acquisition Program:* Acquires and manages sensitive lands for multiple public and environmental benefits. The program manages thousands of acres of community forests in residential areas for reduction of wildfire risk, forest health and habitat improvement.
- *Tahoe-Central Sierra Initiative:* A partnership with the Sierra Nevada Conservancy, USDA Forest Service, and others to restore 2.4 million acres across three national forests.
- *Tahoe Fire and Fuels Team:* A partnership of 20 fire, land management, and conservation agencies implementing the Lake Tahoe Basin Community Wildfire Protection Plan.
- *Land Bank Program:* Supports sustainable development by transferring development rights from environmentally sensitive parcels to more suitable areas.
- *Upper Truckee River Watershed Partnership* – A collaborative interagency effort to restore the Basin's largest and most ecologically significant watershed.

Sacramento-San Joaquin Delta Conservancy

Working collaboratively and in coordination with local communities, the Conservancy leads efforts to protect, enhance, and restore the Delta's economy, agriculture and working landscapes, and environment, for the benefit of the Delta region, its local communities, and the citizens of California.

The Sacramento-San Joaquin Delta Conservancy was created as part of the 2009 Delta Reform Act to be a lead agency for ecosystem restoration and efforts that promote environmental protection and the economic wellbeing of Delta residents. The Conservancy continues to lead regional restoration planning efforts that work directly with local interests, science experts, and State and federal agencies to identify restoration priorities and achieve them in a way that brings the best possible results for all members of the Delta community.

Delta Carbon Program

Strategies: Wetland restoration; Cropland management

The Conservancy's climate change policy guides its efforts to develop, establish, and support projects that mitigate for climate change by reducing GHG emissions or increasing the system's capacity for climate change adaptation. For the past several years, the Conservancy has been part of a considerable partnership that also includes The Department of Water Resources, California Department of Fish and Wildlife, U.C. Berkeley, the American Carbon Registry, the Nature Conservancy, and Hydrofocus, Inc. This partnership has worked to develop pilot projects and inform policies that recognize the Delta as a significant carbon sequestration opportunity area.

Sandhill cranes fly over Staten Island in the Delta. Photo: Florence Low / California Department of Water Resources

Cultivation of conventional cropland (e.g. corn and alfalfa) gradually decreases land surface elevation due to the oxidation of peat soils, causing some islands to be more than 25 feet below the surrounding Delta waters. This imbalance diminishes the capacity of levees to protect the land from inundation. If levees fail, sea water may contaminate Delta water which would be catastrophic to the Delta ecosystem and the California water system and have extensive negative impacts to the economy statewide. In addition, the oxidation of Delta peat soils produces approximately 2,250,000 MMT of carbon emissions annually, or the equivalent of approximately 500,000 vehicles per year.

The Conservancy and its partners developed a protocol (that received American Carbon Registry's Innovation Award) to quantify GHG emission reductions in the Delta. The partnership is working with public and private owners of working lands and project developers to initiate pilot projects to verify CO_2 emission reductions achieved by switching Delta lands from traditional crops to rice cultivation or wetlands. These changes will stop, and in the case of wetlands reverse, subsidence and will decrease the resulting carbon emissions. Upon demonstrating the protocol, Delta farmers will be able to sell carbon offsets on voluntary markets and the California Air Resources Board will

consider adopting it under the Cap-and-Trade compliance market, thereby doubling credits' value and further incentivizing change.

Ecosystem Restoration Program

Strategies: Coastal and Delta Ecosystem Management

The Delta Conservancy Ecosystem Restoration Program increases resilient carbon sequestration by protecting wetland habitats that accrete soil and emit significantly less CO_2 than lands farmed for traditional crops. The program focuses on leading collaborative efforts with other governmental and non-governmental entities and citizens of the Delta to protect, enhance, and restore the Delta ecosystem.

To date, the Delta Conservancy has awarded a total of $24 million to 19 projects with funds from the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1). Completion of these Proposition 1 Grant projects will result in:

- 3,899 acres of aquatic habitat;
- 548 acres of riparian habitat;
- 66 acres of upland habitat; and
- 5,158 acres of multi-benefit flood management.

Related programs:

Other Delta Conservancy programs that support the Natural and Working Lands Implementation Plan also include:

- *Agricultural Collaboration:* Conservancy staff are engaging Delta farmers in listening sessions to learn about priorities for supporting and obstacles to a resilient Delta agricultural system. Staff will continue the collaboration with local agricultural interests to help inform Delta Conservancy programs and policies to support a resilient agricultural industry.
- *Regional Planning:* The Delta Conservancy is leading efforts in which community engagement, best available science, and adaptive management are the cornerstones of planning to ensure effective investment of current Proposition 1 funding and other future funding. Completed in 2017, phase 1 of a pilot effort in the Cache Slough involved evaluating existing ecosystem, agriculture, water supply, and flood system information to begin the effort of overlaying information sets and identifying opportunity areas. In a separate effort, the Conservancy is convening owners and managers of publicly owned or publicly financed lands in the Delta, largely along a corridor from the West Delta up through the Mokelumne system. Nearing completion, this effort shows great promise for coordinating restoration activities on public lands to achieve ecosystem objectives while keeping private agricultural lands in production.
- *Economic Development Program:* This program provides recreational, cultural, and economic benefits to the Delta community and has helped establish a unique Delta brand. In cooperation with the Delta Protection Commission and with assistance from a marketing consultant, the Conservancy created a 5-Year Marketing Plan and a new tourism website for the Delta (visitcadleta.com) to improve the visibility of the Delta, enhance the resiliency of the Delta economy, and promote the Delta's agricultural and recreational significance.

San Diego River Conservancy

The San Diego River Conservancy's mission is to preserve, restore and enhance the San Diego River Area. The San Diego River Conservancy seeks to protect and preserve the health of natural, cultural, historic, and recreational resources in the San Diego River Watershed by preserving and promoting a river corridor that connects habitat conservation areas, parks, and public open spaces.

Since its inception, the San Diego River Conservancy has supported effective land management and conservation practices which also reduce GHGs and mitigate climate change impacts. The San Diego River Conservancy plans to broaden work with our partners to continue to develop projects that address forest sustainability, meadow restoration, carbon sequestration, rehabilitation of wildlife habitat, healthy watersheds, water quality and supply, healthy communities, and climate change resiliency.

Fire management through invasive plant removal and control

Strategies: Improved forest health and reduced fire severity; Grazing land and grassland management; Riparian restoration

In San Diego, mild temperatures and precipitation promote abundant vegetation growth. In the summer, this biomass accumulates, dries out, and creates fuel. When fuel load is ignited, large areas of habitat burn. Factors like climate change, drought, human activity, high winds, and urban sprawl contribute to California's growing fire-prone landscape. The catastrophic Cedar Fire in 2003 burned 273,246 acres, over 13% of San Diego County, destroying 2,820 buildings, killing 15 people, and decimating approximately 209,118 acres (75%) of the San Diego River watershed, resulting in $1.3 billion in damages.

Following the Cedar Fire, the San Diego River Conservancy's invasive removal and control program has helped native species regenerate and have reduced the risk of subsequent fire. Post-fire vegetation is usually dominated by herbs, shrubs, some oak species, and non-native re-sprouts. While the landscape may sometimes return to its former climax community, exotic plant species can out-compete native plants for resources. This vegetation type-conversion has occurred in the upper watershed of the San Diego River. Postfire vegetation surveys indicated invasive Palmer Lilac increased from 3% to 31% and the cover of non-native annual grasses rose from 3% to 40%, outcompeting native vegetation. Invasive non-native vegetation impacts native ecosystems by changing the fire regime. If fire frequency or intensity are changed to encourage the dominance of invasive plants, an invasive plant – fire regime cycle can be established, which is difficult to reverse. In Western North America, cheatgrass has increased fire frequency to the point that some native species cannot recover. Giant reed (Arundo donax) increases vertical continuity in fires and changes surface fires into crown fires. To prevent this activity, the Conservancy developed an invasive non-native plant control program and obtained the necessary permits to remove invasive non-native vegetation in the San Diego River watershed. As of June 2018, the Conservancy has removed and treated over 200 acres. The removal of non-native plants not only improves the watershed's ability to function but also makes unanticipated forest fires manageable.

Conserving land for habitat and recreation within the San Diego River Watershed

Strategies: Land protection

The San Diego River Conservancy works to expand opportunities for recreation and protect habitat within the San Diego River watershed through land conservation projects that protect open space and reduce urban sprawl. For over ten years, the San Diego River Conservancy has acquired land to build and extend the San Diego River trail. When complete, the River-long park and hiking trail will stretch fifty-two miles from the River's headwaters near Julian to the Pacific Ocean, supporting recreation and reducing vehicle miles traveled by providing alternatives for active transportation. Other projects, such as the 2016 Temescal Creek Land Acquisition in the headwaters of the San Diego River, protect key ecosystems. The Temescal Creek Land Acquisition preserved a 75-acre wildlife corridor in the headwaters of the San Diego River, conserving meadows and oak woodlands that provide habitat for cougar, mule deer, and other species.

San Gabriel and Lower Los Angeles Rivers and Mountains Conservancy

The Rivers and Mountains Conservancy (RMC) mission is to preserve open space and habitat to provide for low-impact recreation and educational uses, wildlife habitat restoration and protection, and watershed improvements within our jurisdiction.

RMC supports:

- Conservation and restoration of open space along the rivers and tributaries, in the mountains, hills and foothills, and in urban areas;
- Preservation of critical habitat linkages;
- Expansion of water quality and water reliability projects and programs for watershed improvements;
- Preservation, protection, and enhancement of natural resources;
- Restoration and preservation of wetlands;
- A comprehensive network of trails and bike paths to connect open spaces.

Los Cerritos Wetlands

Strategies: Wetland Restoration

Historically, the estuary of the San Gabriel River encompassed over 2,400 acres of coastal wetlands. Over the past 150 years, urbanization has reduced this wetlands area to just 500 acres of undeveloped land, which is referred to collectively as the Los Cerritos Wetlands. Of this remaining 500 acres, just 50 acres are still functioning tidal wetlands with the remaining acreage existing at various levels of degradation. Much of the land currently or historically has been used for oil production, which involved greatly manipulating the landforms so that most of the natural hydrology and corresponding habitat types have been degraded or destroyed. Los Cerritos Wetlands is one of the last remaining, un-restored coastal wetland systems in southern California.

The Los Cerritos Wetlands Authority (LCWA) is a joint powers agreement created in 2006 an consists of the RMC, California State Coastal Conservancy (SCC), and the cities of Long Beach and Seal Beach. The LCWA was formed to provide a comprehensive program of acquisition,

protection, conservation, restoration, and environmental enhancement of the Los Cerritos Wetlands. The LCWA has acquired 177 acres of land since its inception and in 2015 completed a comprehensive conceptual plan for restoration of the entire Los Cerritos Wetlands complex in Long Beach and Seal Beach.

The Los Cerritos Wetlands Restoration Project affords the opportunity to restore approximately 500 acres of salt marsh, seasonal wetlands, and other freshwater wetlands. In addition, this project has great potential to include broad wetlands transition zone and upland buffer in order to prepare the site for predicted impacts of sea level rise and to reduce urban impacts on the restored wetlands. Restored wetlands will provide carbon reduction benefits, water filtration benefits, and heat reduction and habitat benefits that will become more important as climate change brings more intense storms and heat, stressing natural systems. Simultaneously, restoration allows for flood control facilities to be upgraded and improved to protect the surrounding community and existing industry from future flood hazards.

Lower Los Angeles River Revitalization Plan

Strategies: Riparian restoration; Urban forestry and urban greening; Land protection

The Lower LA River Revitalization Plan (LLARR Plan) seeks to inspire local advocates and decision-makers and serve as a guide for creating vibrant spaces in the Lower LA River (LLAR) corridor which are beneficial to all members of the community and the environment.

Water and environment-related goals of the LLARR Plan include conserving and restoring natural river and watershed functions while managing flood risk, enhancing the long-term ecosystem services provided to surrounding communities, and mitigating climate changes and environmental impacts of urbanization on the LLAR, floodplains, and associated habitats. Specific objectives to meet those goals include improving the environmental quality of the river corridor by restoring the recreational and ecological benefits of the LLAR for surrounding communities and protecting human health and the environment by using nature-based solutions to capture polluted runoff, remediate soil contamination, and improve air quality. Additionally, the LLARR Plan strives to restore or enhance biodiverse, climate-resilient, self-sustaining ecosystems (including native species both instream and upland) throughout the river corridor wherever possible, and to enhance natural hydrological processes and floodplain reclamation necessary for long-term health of the watershed and the community.

A 40-member working group was formed to lead the development of the LLARR Plan, which was chaired by the RMC and managed by the Los Angeles County Department of Public Works

(LACDPW). Members of the working group were selected to represent the cities, neighborhoods, and non-profit organizations serving the river corridor. The Working Group and community identified locations for revitalization efforts within the river corridor—155 opportunity projects were identified. These locations have attributes which can be leveraged into multi-benefit projects and include publicly-owned open space areas, which could be developed into revitalization projects such as multi-use trails, community recreation areas, greenways, river-bed enhancements, or safe river crossings. The Dominguez Gap Wetlands, a project built by LACDWP in 2008, is a treatment wetlands and spreading grounds project already along the LLAR and seen as a template for revitalization projects.

Related Programs:

- *Land Protection*: River Wilderness Park is a 116-acre regional landmark for open space and wilderness access located at the gateway to the San Gabriel Mountains National Monument. The park is envisioned as a unique outdoor learning environment for families and local youth at a metro-adjacent nature destination to enjoy the rich and varied surroundings of the San Gabriel River and San Gabriel Mountains. RMC funded the acquisition, park planning, and part of the park implementation (currently in-process).
- In addition, RMC supports acquisition and restoration of open spaces along the San Gabriel Mountain foothills and inholdings in the Angeles National Forest.
- *Oak Woodland/Walnut Woodland Protection:* Walnut Creek Habitat and Open Space is 61-acres open space which has walnut and oak woodlands, coastal sage scrub, and access to Walnut Creek, one of the only undeveloped urban creeks in LA Region, through a regional Trail. RMC provided funding for the acquisition and current restoration and trail planning.
- *Riparian Restoration*: The DeForest Park Wetlands Restoration Project proposes to restore a 34-acre flood detention basin adjacent to the lower Los Angeles River. Currently the project site is a degraded wetland dominated by exotic species and degraded pedestrian trail. RMC funds are supporting restoration of such multi-purpose wetlands in several areas along the lower LA River's flood retention basins.
- *Urban Greening and Urban Forestry*: RMC funds projects that promote stormwater capture and storage, reduce stormwater pollution, and increase tree canopy in parks, in parkway basins, and at school sites.

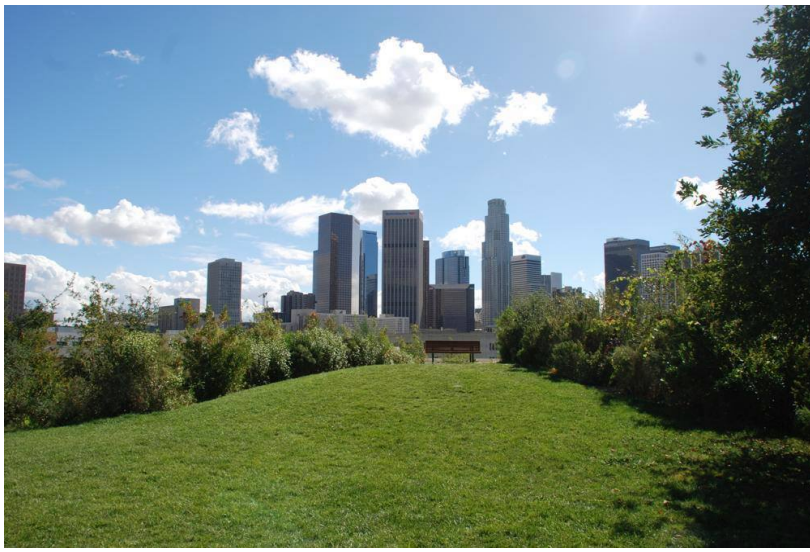
Santa Monica Mountains Conservancy

The Santa Monica Mountains Conservancy's mission is to strategically buy back, preserve, protect, restore, and enhance treasured pieces of Southern California to form an interlinking system of urban, rural, and river parks, open space, trails, and wildlife habitats that are easily accessible to the public.

The Santa Monica Mountains Conservancy (SMMC) develops policy and distributes grants for projects that conserve and restore resources, sequester carbon, reduce GHGs, enhance habitat, and make Southern California's communities, environment, and infrastructure more resilient to climate change.

Urban Greening and Green Infrastructure

Strategies: Urban forestry and urban greening



Vista Hermosa Natural Park, an urban park at the western gateway to Downtown Los Angeles.

The SMMC's Grant Programs fund and prioritize projects that reduce GHG emissions by sequestering carbon, decreasing energy consumption, and reducing vehicle miles traveled. In addition to providing an attractive amenity for urban households, urban green spaces can be a cost-effective way to reduce GHG emissions. Multiple benefit parks that incorporate water recycling and filtration techniques produce verifiable water and energy savings, while urban parks also reduce the heat island effect, improve air quality, and sequester carbon. Furthermore, strategic development of parks, bike paths and greenways along waterways encourages non-motorized transit and promotes investment in disadvantaged or park-poor neighborhoods. Green infrastructure investments provide parks, vegetation, water infiltration and other natural infrastructure to sequester carbon, filter air pollutants, temper heat islands, promote active transportation and incentivize urban (instead of sprawl) living.

Funding is prioritized for projects located within, and providing benefits to, disadvantaged and low-income communities. Delivering multi-benefit green infrastructure can help address longstanding inequalities of opportunity and risk in low-income areas. For example, carbon mitigation in urban areas should include reducing energy use, such as lessening reliance on motorized transportation and lowering home energy use required for cooling. The economic co-benefits of facilitating these changes will have particularly meaningful benefits in low-income neighborhoods where energy costs have a disproportionate impact on household budgets. Further, the inequitable distribution of green infrastructure amenities also exacerbates the climate vulnerability of low-income populations to threats such as extreme heat and flooding. The strong correlation between urban tree cover and income level within means that low-income neighborhoods where residents are less likely to have air conditioning and more likely to face heat-related health risks also have the most intense urban heat islands.

Resource Protection and Restoration

Strategies: Urban forestry and urban greening; Land protection; Grazing land and grassland management; Chaparral and shrubland restoration and management

SMMC's Grant Programs provide funding for projects that contribute to mitigation of the environmental impacts of development. Resource protection and restoration projects facilitate the protection and restoration of wildlife, habitat, and historical/archaeological resources, including habitat restoration projects in urban or rural areas. Two notable examples are the acquisition of Triangle Ranch and the restoration of the Los Angeles River.

Triangle Ranch: The 321-acre Triangle Ranch property is located south of the Ventura Freeway, just outside the boundaries of the City of Agoura Hills. It is approximately 36 miles from downtown

Los Angeles and approximately 20 miles from the nearest rail line in Camarillo. In September 2018, the Mountains and Recreation Authority (MRCA) announced that it had acquired 170 acres of the property, completing the third phase of an acquisition funded by partners including the State Wildlife Conservation Board, the Santa Monica Mountains Conservancy, the County of Los Angeles, the City of Agoura Hills, and the nonprofit Conrad N. Hilton Foundation. The Conservancy contributed a total of more than $9.8 million to all three phases of the acquisition with a combination of grants from Propositions 40, 50, 84, 1 and 68. The new parkland adds to more than 500 contiguous acres of protected open space owned by the Conservancy and the MRCA in this area, protecting broad swaths of coast live oak woodland, chaparral, purple sage scrub, native and annual grassland, and valley oak savannah. Negotiations are pending for the fourth and final phase of the project, which includes 150 additional acres. This is anticipated to be completed in 2019.

The subject property has a fully approved 61 single-family residential lot subdivision. The estimated population increase would not only result in temporary air quality impacts and GHG emissions during grading and the construction of housing units, but also a long-term increase in carbon dioxide emissions from transportation and energy. Approximately 2,861 metric tons of carbon dioxide that would be emitted each year from increased transportation energy consumption.

Developing the property would also significantly hinder the property's potential to serve as a local carbon sink given its large size, tree cover, and natural open space areas. Multiple Mediterranean communities in Southern California have high capacities for sequestering greenhouse gas emissions, especially in large hillsides and canyons that are characteristic of the subject property. New development would also exacerbate heat island effects by reducing natural open areas that could otherwise provide cooler air temperatures to its surroundings.

Los Angeles River Restoration: Recognizing the natural resource value of the Los Angeles River (River), the Conservancy has been planning and implementing riparian restoration projects since 1994. Beginning with the eight-mile soft bottom portion of the river extending south from Griffith Park to Downtown, the Conservancy and the Mountains Recreation and Conservation Authority (MRCA) began to develop parks along the river connecting densely populated neighborhoods with parkland and recreational opportunities. Since the 1940s, the County of Los Angeles and Army Corps of Engineers have managed the River as a concrete flood channel. The communities through which the River passes have had limited contact with or responsibility for the River. In the last several decades, the River has received greater public attention and support for its restoration and availability as an environmental and recreational resource.

Assembly Bill 1558 (AB 1558), Chapter 452, Statutes of 2017 requires the Santa Monica Mountains Conservancy and the San Gabriel and Lower Los Angeles Rivers Conservancy to collaborate with the Department of Parks and Recreation, the California Conservation Corps, and the State Lands Commission to develop a river ranger program to provide a network of river rangers who assist the public at sites along the Los Angeles River and its tributaries, as prescribed. The legislation requires the Conservancies to develop a plan for the design and implementation of the program. Assembly Bill 466 (AB 466), Chapter 341 of the Statutes of 2017, established, within the Conservancy, the Upper Los Angeles River and Tributaries Working Group (Working Group). AB 466 requires, through watershed-based planning methods and community engagement, the

Working Group develop a Revitalization Plan for the Upper Los Angeles River, the tributaries of the Pacoima Wash, Tujunga Wash, and Verdugo Wash, and any additional tributary waterway that the Working Group determines to be necessary.

Related programs:

- *Resource Protection and Restoration Projects.* Projects which facilitate the protection and restoration of wildlife, habitat, and historical/archaeological resources, including habitat restoration projects in urban or rural areas.
- *Vegetation Management and Fire Safety Projects.* Projects which facilitate fire safety and any required or recommended fuel modification zones.
- *Visitor Serving Development and Improvement Projects.* Projects which provide for enhanced visitation, urban accessibility and safety to open space, parks and greenspace, including signage, restrooms, parking, trail building or repairs, and new projects to provide improved accessibility per the Americans with Disabilities Act (ADA).
- *Community Access, Education and Interpretation Projects.* Projects which are required to achieve or expand the outreach mission of a project and provide interpretive programs and materials to substantially enhance knowledge, appreciation, and enjoyment of the natural environment, open space, parklands and rivers.

Sierra Nevada Conservancy

The Sierra Nevada Conservancy (SNC) initiates, encourages, and supports efforts that improve the environmental, economic, and social well-being of the Sierra Nevada Region, its communities, and the citizens of California.

The Sierra Nevada is an extraordinary region of Statewide, national, and even global significance. It is the origin for more than 60 percent of the State's developed water supply and stores massive amounts of carbon in its forests and natural working lands. The region sustains 60 percent of California's animal species and almost half of its plant species, supplies up to half of California's annual timber yield, and produces 70 percent of the State's hydroelectric power. Agriculture, forestry, ranching, and recreation are the most common land uses on private lands in the Sierra and produce a wide range of goods and contribute to the State's overall economy. Historically, Sierra Nevada forests have helped regulate our climate by removing carbon dioxide from the atmosphere and storing it as carbon in the soil, branches, and trunks of trees.

Between 2010 and 2017, over 200 million trees in the Sierra Nevada were killed by wildfire, bark beetles, and drought. Once dead, these trees stop absorbing carbon dioxide and begin to release their stored carbon back to the atmosphere, turning them from a net sink to a net source of GHG emissions. The Region is facing a steadily changing climate that will exacerbate these threats and create new ones. Changing precipitation patterns and increasing temperatures are having a profound impact on the Sierra landscape, affecting its environmental, economic, and social well-being and that of all California. The good news is that the activities that reduce the risk of large, damaging wildfires and strengthen forests against drought and bark beetles also protect carbon storage and sequestration in the Sierra Nevada. SNC is working with partners to significantly

increase the implementation of these activities, including thinning and prescribed and managed fires, enhancing forest resilience to climate change, increasing carbon sequestration, and lowering emissions. Healthy forests, even during more challenging climate conditions, can continue absorbing carbon from the atmosphere at a significant rate, and the larger the tree, the more carbon it will pull from the atmosphere on an annual basis. The SNC developed the Watershed Improvement Program as an integrated, collaborative approach to increase the pace and scale of needed actions at a landscape level and across all issues to address the magnitude of the challenges resulting from current conditions and a changing climate.

Sierra Nevada Watershed Improvement Program

Strategies: Improved forest health and reduced wildfire severity; Enhanced carbon in forested ecosystems; Reforestation; Grazing land and grassland management; Riparian restoration; Land protection

The Sierra Nevada Watershed Improvement Program (WIP) is a coordinated, integrated, collaborative program to restore the health of California's primary watershed through increased investment, needed policy changes, and increased infrastructure. This comprehensive effort is organized and coordinated by the SNC in close partnership with other federal, State, and local agencies, as well as diverse stakeholders, and aims to increase the pace and scale of restoration in the Region. The WIP was recognized as a model for implementation in California's Forest Carbon Plan. When healthy, the Region's forested landscapes sequester and store more carbon than any other ecoregion of the State. Overstocked fuels and tree mortality threaten this carbon sink and the WIP identifies workable solutions to the complex policy, economic, social, and physical challenges to restoring and protecting forest and watershed health.

A prescribed fire in the Sierra Nevada. Photo: Sierra Nevada Conservancy.

Tahoe-Central Sierra Initiative

Strategies: Improved forest health and reduced wildfire severity; Enhanced carbon in forested ecosystems; Reforestation; Grazing land and grassland management; Riparian restoration; Land protection

The Tahoe-Central Sierra Initiative (TCSI) is an innovative all-lands, landscape-scale implementation model under the umbrella of the WIP, established to accelerate regional-scale forest and watershed restoration through ecologically based management actions while creating the opportunities to support a forest restoration economy and explore innovative process, investment, and governance tools. The TCSI builds on a legacy of successful partnerships in the Tahoe region

and is led by the Sierra Nevada Conservancy and the California Tahoe Conservancy, in partnership with the U.S. Forest Service, National Forest Foundation, The Nature Conservancy, California Forestry Association, USDA Forest Service Pacific Southwest Research Station, University of California-Natural Reserve System, and Sagehen Creek Field Station. The TCSI encompasses 2.4 million acres in the Lake Tahoe Basin and the American, Bear, Carson, Truckee, and Yuba watersheds. The TCSI area is a critical contributor to the State's watershed, and its forests contain large amounts of carbon, provide significant habitat, and are a recreational playground for millions of visitors. Its proximity to urban areas provides the opportunity to demonstrate clear links between upstream and downstream watershed health and show restoration impacts firsthand. Significant infrastructure investments in water, hydropower, electricity, telecommunications, transportation and recreation serve large populations of Californians and are threatened by increasing risk of wildfire. The checkerboard land-ownership in the region requires a collaborative, coordinated response to take a stand against the wave of tree mortality that has devastated so many southern Sierra forests, as well as catastrophic mega-fires impacting the state's unhealthy forests. TCSI is a model that can be applied across the entire Sierra Nevada Region and other areas of the state to dramatically accelerate the restoration of a resource that is rapidly deteriorating. In 2017 and 2018 the TCSI collaboration enabled the dedication of over $32.5 million of Climate Change Investment dollars towards strategic on-the-ground projects that enhance climate adaptation and resilience of forests and watersheds.

Related programs:
SNC administers and is developing several grant programs funded through Propositions 84, 1, and 68 which support projects that advance the goals of the Natural Working Lands Implementation Plan while securing multiple other watershed benefits.

- *Proposition 1 & 68 Sierra Nevada WIP Grant Program - Healthy Forests:* supports forest health projects that result in a combination of multiple watershed and ecosystem benefits, including improved water quality and yield, increased carbon sequestration and reduced greenhouse gas emissions, reduction in high-intensity fire and the negative consequences of such fires.
- *Proposition 68 Strategic Lands Conservation Grant Program:* supports fee title acquisitions and conservation easements that protect unique cultural and natural areas, working ranch and forest landscapes, critical wildlife habitat, or access to public lands.
- *Resilient Communities:* supports technical assistance and training to local governments, community organizations, and tribes, with an emphasis on disadvantaged communities.
- *Collaborative Recreation and Tourism:* supports innovative, collaborative efforts to enhance, promote, develop, and maintain sustainable recreation and tourism opportunities in the Sierra Nevada Region.

State Coastal Conservancy

The State Coastal Conservancy's vision is of a beautiful, restored, and accessible coast for current and future generations of Californians. We act with others to protect and restore, and increase public access to, California's coast, ocean, coastal watersheds, and the San Francisco Bay Area.

The Coastal Conservancy has specific authority to implement climate mitigation and adaptation projects. Our work supports carbon sequestration in conserved forests, on coastal agricultural lands, and in restored wetland and subtidal habitats. The Coastal Conservancy is a leader within the State implementing projects that use natural lands to increase climate resilience.

Restoring California's coastal wetlands

Strategies: Wetland restoration

The Coastal Conservancy is leading efforts to restore estuarine wetlands all along the coast. Tidal wetlands are carbon dense ecosystems that sequester large amounts of carbon from the atmosphere continuously over thousands of years. Tidal wetlands store high concentrations of carbon due to their high productivity, continuous sediment burial, and relatively slow decomposition rates. One significant regional project is the restoration of salt ponds in the South San Francisco Bay to tidal wetlands will convert diked bay lands into estuarine wetlands. Ultimately, this project will restore 15,000 acres of wetlands, and the Conservancy has led planning and implementation of restoration of 3,300 of these acres.

Carmel River wetlands

Protecting forests on California's North Coast

Strategies: Enhanced carbon in forested ecosystems

The Coastal Conservancy has supported protection of more than 120,000 acres of coastal forests that sequester and store significant amounts of carbon. For example, the Coastal Conservancy was a major funder of The Conservation Fund's acquisition of the Buckeye Forest, the Garcia River Forest, and the Big River Salmon Creek Forest. All three of these properties were previously harvested forests, acquired with the intention of protecting watersheds and restoring these working forests over time using careful, light touch forestry that allows the forests to recover to a more natural structure, while simultaneously increasing the forests' ability to store greater amounts of carbon. These three projects are registered with the California Air Resources Board under its Compliance Offset Program. The Conservation Fund has sold carbon credits, generating much needed revenue for forest management. Using conservative projections, The Conservation Fund expects these three forests to collectively sequester 5,000,000 $MtCO_2e$ over the next 20 years.

Related programs:

- *Enhanced carbon in forested ecosystems:* Many Coastal Conservancy projects to protect and restore coastal forest ecosystems, including both small and industrial-sized working forests, and forests acquired for parks.
- *Grassland and grazing land management; oak woodland and riparian restoration::* A number of Coastal Conservancy projects have restored oaks, grasslands and riparian ecosystems throughout coastal counties of California, such as the 703-acre Puerco Canyon property acquisition in Los Angeles County in 2014.
- *Wetland and seagrass restoration:* At the forefront of work to restore coastal wetlands and subtidal habitats including eelgrass throughout coastal California and around the San Francisco Bay Area, the Conservancy has participated in the planning or restoration of nearly 35,000 acres of wetlands in the Bay Area alone. Additionally, the Coastal Conservancy staffs the San Francisco Bay Restoration Authority and the Southern California Wetlands Recovery Project.
- *Agricultural management:* The Coastal Conservancy has supported projects with Resource Conservation Districts along the coast and in the San Francisco Bay Area, and with a tribal farm in southern California to develop carbon farm plans and implement carbon farming techniques.
- *Urban greening*: Urban greening projects supported by the Coastal Conservancy throughout the state have created new parks, improved existing parks and green spaces, and planted trees, making our urban communities more livable. These projects can infiltrate stormwater, improve groundwater recharge and water quality, reduce urban heat island effects, improve air quality, and increase walkability and safety.
- *Land conservation for sustainable development*: Several significant Conservancy land conservation projects have helped prevent sprawl development in all coastal counties and throughout the San Francisco Bay Area.