**AB 1757 Expert Advisory Committee**

**Proposed Targets for Deserts**

**SECTION 1.** **Outline scope and importance of land sector**

The Mojave, Colorado and Great Basin Deserts of California are considered globally significant areas characterized by supporting a high diversity of plants and wildlife as well as providing numerous ecosystem services for humans, including municipal, commercial and recreational opportunities. This region is the ancestral homeland of tribal communities, and is a unique and sensitive habitat with a rich cultural and natural history associated with certain regions.

Various California state assessments have addressed the characteristics and importance of Californian Desert regions and we briefly summarize those here. First, the [2022 California NWL Climate Smart Land Strategy](https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Expanding-Nature-Based-Solutions/CNRA-Report-2022---Final_Accessible.pdf) considers lands with <10% cover as sparsely vegetated lands; this definition covers 10% of the state (10.2 million acres), and includes desert, beach and dune areas with less than 10% vegetation cover, bare rock landscapes, and areas covered in ice or snow such as those above the tree line in mountainous regions. Second, [California’s Fourth Climate Change Assessment](https://climateassessment.ca.gov/) (2018) and the 2022 [California Climate Adaptation Strategy](https://climateresilience.ca.gov/) both characterize the inland desert region as encompassing the Mojave and Sonoran deserts in the southeast corner of the state, including all of Imperial County and the desert portions of Riverside and San Bernardino Counties. This region has the largest amount of federally protected lands in the state – 7,448 square miles of National Parks and Monuments, including important wildlife refuges and unique ecosystems. In the Mojave Desert, there are approximately 210 species of plants that are found nowhere else on Earth. There are many iconic plants and animals that would benefit from increased conservation investments, including Joshua trees, threatened desert tortoises and Mohave ground squirrels, desert bighorn sheep and golden eagles. The tribal lands of 12 different groups are located in the region, and overall this area has about 1 million inhabitants, with 85% of those residing in urbanized areas including the Victor Valley in San Bernardino County, the Coachella Valley in Riverside County, and the El Centro Metropolitan Area in Imperial County.

The 4th Climate Change Assessment estimates that future development will likely take place within and amongst these urbanized areas. Agriculture is the primary driver of the Inland Deserts region’s economy, followed by tourism (largely in the Coachella Valley) and is also an important region for transportation, logistics and warehousing, and real estate development, which includes housing and renewable energy. Agriculture in the valleys is nearly completely irrigation dependent, and the already-high water demand in the region will likely increase with rising evapotranspiration rates under a warmer climate. Solar farms, largely on federal lands in the Colorado Desert of California, currently represent one of the densest areas of solar development in North America. Imperial Valley also contains some of the largest lithium deposits in the world. Solar and lithium extraction have been forecasted to increase significantly in the region, but with potentially significant and unwanted impacts to already strained water resources, carbon storage, biodiversity, and environmental and public health.

California's deserts store nearly 10% of the state's carbon. This carbon is stored underground in the soil and root systems, and above ground in biomass. Research has shown that the construction and operation of large-scale solar and other extraction projects scrape the desert bare of vegetation across thousands of acres, disrupting ecological processes and leads to habitat fragmentation, and impact gene flow and prevents movement in species such as bighorn sheep, deer, and the desert tortoise (Lovich et al. 2011, Tawalbeh et al. 2021). Further, lichens, along with bacteria and moss, form a biological soil crust that acts as a protective barrier for desert ecosystems, helping prevent erosion, creating a nutrient-rich growing environment and increasing water retention (Finger-Higgins et al. 2022). Surface-disrupting projects impact these natural resources, and the disturbance notably threatens carbon sequestration capabilities in these regions (Allen et al. 2023). Careful consideration of solar development and lithium extraction is critical to avoiding potential long-term damages to the carbon sequestration capacities, as well as significant threats to the conservation of water, biodiversity, ecosystem services, and cultural history associated with these regions.

Uncertainties around these ecosystems exist around the monitoring and modeling of carbon stores. Some unknowns concern the pulse-driven nature of desert biogeochemistry and nitrogen fluxes can be substantial, and also difficult to capture. Further, inorganic carbon is a critical carbon pool not currently adequately captured in carbon sequestration estimates in desert region ecosystems. The desert’s carbon storage process differs significantly from more widely understood sectors such as forests, grasslands, chaparral, and wetlands (Allen et al. 2023). More research is needed to address these areas.

**SECTION 2.** **Recommended actions, strategies, and implementation target(s)**

Given their carbon storage capabilities, conservation of large, intact desert areas and restoration of sensitive habitats could have a high return on investment for climate mitigation. Particular care should be taken in recognizing Death Valley (Sierra Nevada – East sub ecoregion) as a desert ecosystem that is unique and separate from others in the Sierra Nevada ecoregion. Importantly, local stakeholders, Tribes and desert communities should be part of the decision-making process to ensure that those groups disproportionately impacted by conservation (or other) efforts in this ecoregion are well represented.

The CARB 2022 Scoping Plan for Achieving Carbon Neutrality recommends cutting land conversion of deserts and sparsely vegetated landscapes by at least 50 percent annually from current levels, starting in 2025. Avoided conversion of sparsely vegetated lands reduces the organic carbon lost from the soil, which is the major carbon pool in this land type. The following provides our recommendations:

•Aligned with the 2022 Scoping Plan, in order to prioritize short-term carbon stocks, the recommendation is to minimize disturbances for sparsely vegetated habitats, the priority action is for no further land conversion aside from the estimated 2,607 acres/per year associated with city growth

•Land conversion occurring outside of the estimated city growth (e.g., new development) is not recommended. If certain land conversion is necessary, appropriate carbon sequestration mitigation, and in addition to prioritization for water, biodiversity and habitat conservation, adequate for timescales relative to desert ecosystems, is required (e.g., carbon credits, restoration, etc.)

•We recommend accelerating the 2022 Scoping plan conservation recommendation of 15,000 acres per year to a minimum of 15,000 acres per year, and a maximum feasible acreage beyond this amount.

•Restoration activities should be targeted toward invasive species removal (e.g., Tamarisk and other species) and restoration of riparian zones in order to prioritize short and long term carbon stocks and important co-benefits for water conservation, biodiversity enhancement and ecosystem health associated with these activities.

**SECTION 3.** **Pathways to reach the implementation target(s)**

In order to achieve the proposed implementation targets provided above, we suggest the following mechanisms. First, increased investment in ongoing state desert and riparian conservation programs can leverage related activities to protect and restore desert ecosystems. These include the Wildlife Conservation Board [Desert Conservation](https://wcb.ca.gov/Programs/Desert) and [Riparian Habitat Conservation](https://wcb.ca.gov/Programs/Riparian) Programs. We recommend that carbon sequestration should become a key priority of these existing programs, including the estimation and measurement of carbon storage associated with each project.

Engagement with key stakeholders is of critical importance. At least 12 tribal groups are associated with Californian Desert Regions - preservation of present-day and historical values for these communities must be prioritized. Major landholders in the region include but are not limited to, the federal Bureau of Land Management and the National Park Service, state California State Parks, and agricultural and other commercial representatives. While any further land conversion is not recommended, the selection and siting of any development proposed by these groups must prioritize carbon stocks, biodiversity, ecosystem health, and water conservation.

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**\*\*\*\* END\*\*\*\*\***

**AB 1757 Expert Advisory Committee**

**Proposed Targets for Agricultural Lands**

**SECTION 1.** **Outline scope and importance of land sector**

Agriculture provides a fundamental service to society and the environment. It must retain flexibility to achieve these goals and provide for food production and security (Porter et al 2014). Agriculture faces many climate and labor challenges over the coming 10 to 50 years (Steenwerth et al. 2014). Agriculture provides mitigation for our changing climate, but the EAC acknowledges the need for investment in adaptations that maximize agriculture’s resistance to climate stressors for food security.

In the last two decades, California agriculture has effectively undertaken a broad effort to both adapt to climate stressors and offer greenhouse gas (GHG) mitigation and carbon offsets. Growers in California use cover crops, sown directly or using resident vegetation, and apply compost. Perennial crop growers adopt these practices more broadly compared to row crops, due to economic restraints. Through successive use (annually), these can provide increases in soil carbon (C), nutrient use efficiency and retention, water holding capacity and soil health. Advanced micro-irrigation practices have led to dramatic reductions in GHG emissions and nutrient loss, and improved crop nitrogen use efficiency. Here, GHGs include carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4). For example, N2O emissions in microirrigation have been reduced to below baseline values in old flood irrigation approaches (Zhu-Barker et al. 2019). Still, blended irrigation designs are needed to manage leaching, alley and wheel track germination for cover crops, and infiltration for groundwater recharge. Even in rice, which utilizes flood irrigation for production, GHG emissions have been significantly reduced due to increases in productivity and changes in water management.

A number of decadal field experiments in California have been completed on effects of compost, cover crop and tillage on soil C. No -till or conservation till shows mixed results with total soil C gains no different or lower than tilled soils with or without cover crops (Koch 2023). No-till soils do enrich surface soils with C compared to tilled soil, increasing infiltration and potentially water holding capacity, therefore providing essential adaptation measures to ensure food security. Annual compost application regardless of tillage can increase soil C by about <0.1 to 0.2 t C per hectare per year (Poudel et al. 1999; Tautges et al. 2019). Compost applications on soil C have mainly been studied in organic production systems and can increase soil C up to 0.3 t C per hectare per year. All soil C gains occurred primarily with the first 10 years and permanency requires perpetual and consistent practice implementation. The C sequestration values are lower, even up to 10x lower than some model predictions. This is likely due to models predicting maximum potential when in practice, climate, grower decisions and economics control the biophysical potential to sequester soil C. The latest preliminary unpublished results suggest that soil C in the above decadal experiments begin to slightly decline from maximum levels after 15 to 20 years of management intended to increase soil C. This is likely due to reaching a new equilibrium and/or impacts of increasing mean annual temperature from our changing climate. The results strongly suggest that current model predictions must be reassessed using new data, climate impacts and changes in irrigation management, which together may lead to lower microbial contribution to soil C maintenance.

Given agriculture’s essential role, we must flip the view from agriculture as a source of C offsets, especially in California’s semiarid Mediterranean climate, to one that reduces its GHG emissions to the greatest extent possible relative to crop production. The reduction in GHG from micro-irrigation approaches contribute significantly more to reducing ‘global warming potential’ (GWP) than the other practices discussed above. The magnitude of the above practices to reduce GWP can be expressed as ‘yield-scaled global warming potential’ (YS-GWP). YS-GWP is meaningful because it includes agriculture’s provisioning services and scales GWP with respect to crop yield providing value to increasing crop nitrogen use efficiency and soil C gains (Zhao et al. 2019).

California agriculture can further expand practices that build soils to support crop productivity. Such practices build soil C for soil health outcomes, improve water use efficiency and nitrogen use efficiency, and can significantly improve environmental quality. However, the State’s Sustainable Groundwater Management Act (SGMA) may require some croplands to go fallow due to water limitation, resulting in the likely loss of soil C with the magnitude dependent on area and frequency of fallowing. These outcomes support human and animal health, which are existing priorities of the state. In fact, the CDFA Healthy Soils Program, which facilitates meeting the AB1757 goals in agriculture, specifically values soil health for its role in supporting bioproductivity, air quality, water quality, animal health, *and* public health in addition to building soil C.

**SECTION 2 & 3 (combined).** **Recommended actions, strategies, and implementation target(s)**

**Implementation Target 1.** Protect farmland and avoid conversion out of agriculture to maintain C stocks, enhance environmental benefits, and facilitate Just Transitions for communities in agricultural regions. By 2050 move 100% of CA farmland into equilibrium status, where all losses due to fallowed land or urban development result in reclamation of unused urban space for agricultural or park utilization. Maintaining agricultural production is a high priority to avoid GHG emissions and C loss that occur as a consequence of land use conversion. Conversion out of agriculture is a true concern for California, given the many competing interests for land conservation and development, and various policies like SGMA.

**Pathways, Strategies and Actions.**

* Initiate local task forces to develop holistic land-use goals by urban planners, developers, farmers, and ranchers to prioritize preservation of agriculture and land restoration. To do so, identify and leverage democratic and community solutions to directly address economic drivers of land conversion (see Implementation Goal 2 for capacity building). Offer financial support to train and employ planners to create processes and objectives in support of a task force plan.
* Build upon the successful models and progressive adoption SALC and CFCP, and previous to those, the Williamson Act. Historically simple Conservation Easement (CE) plans are now being expanded to unambiguously create and integrate multiple layers of environmental and social benefit. The long-term impacts of the earlier one dimensional CEs usually lacked equitable allocation as well as rigorous examination of the impact on land conversion and local agrarian socioeconomics. Newer models should be paired with thorough analysis of eventualities.
* Increase farming systems economic and agronomic resilience in order to increase the near-term financial viability and decrease long-term risk of keeping farms intact and functional. We advise investing in research on the standardization of technical support, farming innovations, and market development to support new crops and practices that will be better adapted to our region in the next 20-50 years. Innovations must enable adaptation to reduced water availability and increasing heat burdens. Ideally, they would bolster financial security by adding another revenue stream to farm operations, reduce their cultural needs and provide health and safety benefits for workers and the community. We identify the need to 1) support research and development of novel systems; 2) study the impacts of these systems on farms, on the state’s agricultural economy, and on co-benefits; and 3) study the potential of these systems to reduce the impact of extreme heat on crops, livestock, and agricultural workers. Examples of emerging systems include alley cropping, livestock integration, polycropping and agrivoltaic systems.

**Implementation target 2.** *Expand farm-edge diversification to support innovation and utilization of liminal spaces in farming systems, which all offer increases in landscape C storage and ecosystem services.* Benefits of this diversification include cooler water in riparian areas, reduced flooding and loss of nutrients from the farm to freshwater, beneficial increases in habitat, and standing aboveground C and soil C on farm edges. Hedgerows also offer windbreaks and beneficial insectaries.

**Pathways, Strategies and Actions.**

* Increase expansion of cultural crops and medicinal plants through germplasm development, technical assistance, market development and other programs for diffusion of innovations. Marginal land is often the only space available to indigenous and traditionally unsupported demographics.
* Increase the capacity to develop and produce regionally suitable plants (germplasm) by climate, region and intended use. Develop infrastructure for scaled regional plant nurseries and invest in workforce development for nursery production of suitable, native plant material. This dovetails with urbanscapes’ need for regionally suitable plants to restore riparian areas, park edges and swales to filter and direct wastewater.
* Support agroecosystem functionality through farm edge diversification on the conservative estimate of 381,000 acres of farm edges in California; target 100% of these edges by 2040. This value does not include available area along gullies, canals, drainage and roadsides.
* Provide investment and grant programs to support: 1) grower access to plant material and capital to implement and sustain these practices and 2) regional technical assistance for riparian forest restoration and production of new plant material. Technical assistance providers include UCCE, NRCS, CCC and RCDs.
* Allow for tax break on area that is restored to riparian forest, cultural crops or hedgerows
* Assess progress by remote sensing techniques, and via mandated reporting through extramural funding mechanisms.

**Implementation Target 3.** *Expand organic agriculture to 75% of farming operations and 40% of farming acres by 2045.* The blended metric focuses on the number of farming operations for a number of reasons that are directly and indirectly related to our GHG goals. We argue that this will allow for community-based accountability in terms of local food security, farmer/worker health and well-being, food miles, local economics and land-use optimization. It will compel programs to be inclusive of diversity of farming operations and stakeholders in a given region by not only prioritizing acreage. This goal allows us to meet AB1757’s target of addressing social justice and equity, as communities where organic agriculture is expanded will have reduced exposure to pesticides.

**Pathways, Strategies and Actions.**

* Provide technical support for the transition to organic agriculture and expand cost-sharing programs that support this transition, as delineated in the CDFA California State Organic Program. <https://www.cdfa.ca.gov/is/organicprogram/costshare.html>. Also, establish a permanent CDFA OT Program that first prioritizes incentives to socially disadvantaged farmer or rancher applicants. If funds remain, funds will be distributed to limited resource farmers or applicants, and lastly, to remaining farmer applicants.
* Invest in and expand programs to reduce barriers and risks for under-resourced farmers to transition to organic farming practices. Specifically, we refer to AB-552 Farmer Equity Act of 2017: Regional Farmer Equipment and Cooperative Resources Assistance Pilot Program. AB-552 was presented to the Governor on 9/20/23 and pending approval.
* Facilitate development of affordable formulations of organic fertilizer that can be delivered via fertigation methods that reduce GHG emissions (i.e. N2O). There are feasible methods but affordable markets must be developed to create reasonable access to such products.
* Develop new markets and expand existing ones for organic products to avoid depressing produce values. Consideration of organic production’s role in food security is key so that high quality produce is available to all. Prioritize efforts initially like ‘Farm to School’ and ‘Farm to Institutions’ like hospitals, prisons, elder care and group homes. For example, establish a permanent CDFA Farm to School Program where at least 20% of procurement funds are targeted toward organic producers; and establish and implement a state procurement program prioritizing purchase of CA-grown organic food by 2028.

**Implementation Target 4.** *Increase access to soil building practices, and continue Investment in integrated fertilizer, irrigation and soil fertility management practices to reduce N2O emissions and build soil organic carbon.* The use of compost, cover cropping, and crop rotations allows for improvements in soil properties prized for increasing crop productivity. Building soil organic matter, often reflected by total organic carbon content, is a key to enhancing functions like soil nutrient retention. Specialty crop growers, such as wine grapes and almonds, tend to have a higher adoption of cover crops compared to annual or row crop growers. Cover crop adoption in specialty crops is as high as 46% (Gould and Rudnick 2018). We identify these practices as ‘no regrets’, but we reveal gaps that need to be addressed to scale them across California’s agricultural system.

Research studies reveal that after practice implementation, most soil C sequestration occurs in the first 10 years, thereafter soils reach a new equilibrium. Once a new equilibrium is achieved soil C may slightly decline due to climate impacts. Once meeting this condition, soil C building practices must remain in place to maintain C permanency. This concept of C equilibria and permanency must be built into the scoping plan, private business models and programs that engage growers to provide this service to others. Who will bear the cost of maintaining C permanency? As such, we prioritize adaptation over mitigation in agriculture, especially since practices such as no-till, compost and cover crops build soil health and food security.

**Pathways, Strategies and Actions.**

* Increase investment in CDFA HSP and collaboration with NRCS EQIP to build upon the 350,000 acres of cover crops in California agriculture reported in the 2017 Ag Census from USDA-NASS.
* Increase capacity for seed production and for climate-adapted cover crops; supply chain is extremely limited by available seed type and volume, with currently about a ⅓ of growers indicating issues with obtaining seed.
* Increase capacity of compost production at local hubs to reduce the transportation costs and fuel emissions, and increase local access to compost per SB 1383. Continue investment and permitting of compost facilities.
* Provide technical assistance, incentives and service to growers not yet utilizing these programs and/or technologies. Further, invest in programs like those described in AB-552 Farmer Equity Act of 2017: Regional Farmer Equipment and Cooperative Resources Assistance Pilot Program to facilitate use of these practices.
* Review and collate existing data sources for soil C and GHG emissions. Use this assessment to identify where the gaps are in data sources to develop an empirical approach to assessing practices that reduce GHG emissions and increase soil C.
* Assess the success of these practices by developing a long-term monitoring network to assess soil C content, nutrient retention, nitrous oxide emissions and nitrate leaching based on practices that are implemented by growers across regions, soil types and climates. This will reduce the high uncertainty surrounding the modeled values used to quantify potential soil C storage potential and nitrous oxide emissions. To this end, conduct an external assessment of available data sources for soil C and GHG emissions to assess where gaps need to be addressed.

**Implementation Target 5.** *We elevate the need for enhanced social dialogue around Just Transitions in California agriculture. This priority crosses all Implementation targets identified for Agriculture.*

The International Labour Organization defines a Just Transition as “...greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind. A Just Transition involves maximizing the social and economic opportunities of climate action, while minimizing and carefully managing any challenges – including through effective social dialogue among all groups impacted, and respect for fundamental labor principles and rights .”

The consequences of decisions and actions we take now are accrued generationally, and evaluation of these goals and their implementation must occur with that perspective. As such, we recommend strengthening the capacity of local communities to define, adapt, and implement strategies to their holistic context. We don't presume to understand the nuances or complexities of the socioeconomic ecosystems in which the agricultural decisions and actions that impact climate resilience are made but we are confident that the most efficacious solutions lie proportionally within the radius proximate to those communities. We advance the report ‘Guidelines for a just transition towards environmentally sustainable economies and societies for all’ by the International Labour Organization and their associated Just Transition Policy brief series (October 2022 - June 2023) as guides to accomplish Just Transitions within Nature-based Solutions.

**Pathways, Strategies and Actions.**

Build and enhance integrated technical and communication networks spanning local to statewide capacities. Prioritize needs of the community and local farming systems to maintain innovation and preparedness of agriculture to our changing climate. Develop and enhance regional innovation and service centers to allow for local capacity building to adapt and mitigate climate change as well as expand access to land tenure and equity within under-resourced or under-served agricultural communities.

* Follow guidance in [www.cdpr.ca.gov/docs/sustainable\_pest\_management\_roadmap/](https://www.cdpr.ca.gov/docs/sustainable_pest_management_roadmap/) to build capacity for equity, communication and community organizing from local to state levels.
* Focusing on integrated engagement among the local climate action planning and target-setting processes with the state-level climate planning processes as a critical step to build this capacity.
* Provide financial support for participating organizations to engage in these processes needed to build coalitions among community members and various institutions. This covers travel and hourly wages for attendance at meetings to offering funds for administration and coordination of this effort to multiple entities involved in the process.
* Address barrier to farmland access and land tenure by supporting community-led land access projects; develop policies that ensure all farmers have good faith options to renew their lease agreements under just cause termination; prioritize inclusion of historically underrepresented farmers equal to/exceeding their demographics in CA; support access to credit for young, BIPOC, small, and diversified farmers; and support business technical assistance for young, BIPOC, small, and diversified farmers.

***P****LEASE CONTRIBUTE*

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Managing Water and Farmland. Transitions in the San Joaquin Valley. Ellen Hanak, Andrew Ayres, Caitlin Peterson, Alvar Escriva-Bou, Spencer Cole, and Zaira Joaquín Morales, with research support from Shayan Kaveh, Amy Mahler, and Annabelle Rosser. September 2023. PPIC.

Appendix A. Use the following table to help guide your decision-making process for generating final targets. (Note: These tables are primarily to help identify and rank options) **NOTE – TBD still as of 10/9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Approach | Targets | Potential  Target A | Potential  Target B | Potential  Target C | Potential  Target D |
| Strategy (a group of actions) underpinning this target | This target includes performing X, Y, and Z actions across XX% of this land type. | This target includes enrolling XXXX acres to this kind of action. |  |  |
| Objectives | Increase durable carbon storage | ++ | ++ |  |  |
| Mitigate other GHG emissions | ++ | UNK |  |  |
| Promotes ecosystem function/adaptation to climate change |  |  |  |  |
| Reduce climate-change risks to human communities (e.g., catastrophic fires, floods, health) |  |  |  |  |
| Regulate water dynamics (e.g., groundwater recharge, flood risk) | UNK | ++ |  |  |
| Support biodiversity conservation (e.g., habitat, resilience, connectivity) | ++ | — |  |  |
| Intended benefit to marginalized, underserved, or frontline communities | ++ | + |  |  |
| Other co-benefits (e.g., reduce heat load, improve water quality, improve air quality, provide open space) | + |  |  |  |
| Promotes food production (and security) | + /UNK | + |  |  |
| Promotes job security | + |  |  |  |
| Leverages current investments | Yes | Yes |  |  |

**Effect sizes**

+++ = Highly beneficial

++ = Moderately beneficial

+ = Slightly beneficial

0 = Neutral effect

— = Slightly harmful

— — = Moderately harmful

— — — = Highly harmful

+/- = Trade-off between benefits and harms

UNK = Unknown effectiveness (unknown to the EAC)

For the final objective in the table, state yes or no.

**Certainty\*--This is a qualitative assessment.**

Very likely (90-100% probability)

Likely (66-100% probability)

About as likely as not (33 to 66% probability)

Unlikely (0-33% probability)

Very unlikely (0-10% probability)

\*Adapted from [IPCC guidelines](https://www.ipcc.ch/site/assets/uploads/2017/08/AR5_Uncertainty_Guidance_Note.pdf). Use expert judgment and discretion when determining a certainty level.

**AB 1757 Expert Advisory Committee**

**Proposed Targets for Grasslands**

**Draft Template**

**SECTION 1.** **Outline scope and importance of land sector**

*Provide a brief summary of the scope and importance of this land type related to climate action in California. Describe key opportunities and challenges specific to this land type, highlighting unique aspects as appropriate. Draw from existing resources, including the Climate Smart Land Strategy, Climate Adaptation Strategy, Climate Scoping Plan, and the primary literature, to inform this section of the report.*

Grasslands are defined as lands that have <10% tree canopy cover and are dominated by grasses or other herbaceous vegetation. Grasslands in California experience considerable diversity in geology, soil type, and climate, with distinctions often made between coastal grasslands, valley grasslands, and cold and warm desert grasslands. California grasslands dominate the Valley floor and extend to oak woodland (savannas) up to elevation of about 1,500 ft. They make up 9-10% of California’s land area totaling approximately 10-14M acres storing about 330 MMT of carbon (C) (Stromberg et al. [eds] 2007; Eviner 2016; 2022 Scoping Plan). Since the 1600’s, introduction of exotic annual grasses by Spanish colonists and overgrazing have drastically altered plant and animal biodiversity. Prior to colonization, some researchers suggest the area was dominated by perennial bunchgrasses such as purple needlegrass (*Nassella pulchra*), the state grass of California. However, other researchers hypothesize that inland grasslands were historically dominated by forbs (Wester 1981; Schiffman 2000). Today, more than 99% of native California grasslands have been converted to development and agriculture. California grasslands can be a source or sink of C depending on the environment and management, with oak woodlands serving as more reliable sinks (Ma et al. 2007). Tree removal in the 1960’s was a standard practice to increase forage production leading to significant loss of soil C. Oak trees and foothill pines create Islands of fertility with increased soil C, about 3x higher than open grassland (Carey et al. 2020; Dahlgren et al. 2003). The majority of the carbon is belowground, which has implications for future stability in a world marked with increasing intensity of wildfires (Dass et al. 2018). In fact, the 2022 CARB Scoping Plan predicts that, unlike some of the other ecosystems, grassland C can be maintained or improved with management even in the face of stressors such as drought. Reintroduction of trees and reducing conversion of grasslands represent management opportunities to increase C stocks. However, grasslands occupy diverse ecological site conditions and soils resulting in varying biogeochemistry and climate conditions that affect the ability to store soil C. Recommended management strategies will differ by grassland type and region and will influence recommendations management actions related to each Target.

Nearly 90% of annual grasslands in California are privately owned (Huntsinger et al. 2007). The primary land management activity on these grasslands is livestock grazing, mainly cattle. Grazing occurs on both private and public lands in California. Many ranchers love ranching for the lifestyle, working with animals, and being in nature, but it is often difficult for ranching to be the sole income. Often times more than one income is required to support a ranching family. While we touch on other land ownership scenarios, our recommendations focus heavily on supporting ranchers so they can protect and restore grassland C.

**SECTION 2.** **Recommended actions, strategies, and implementation target(s)**

*Describe the conservation and stewardship strategies that should underpin climate action in this land type. Draw from, but do not confine yourself to, the recommendations put forth by the Climate Smart Land Strategy, Climate Adaptation Strategy, and Climate Scoping Plan. Recall our guiding principles (defined above) as you generate this section.*

*Using Appendix A as support, generate and list final implementation target recommendation(s). Succinctly describe how each target was decided upon, stating any assumptions or information that contributed to the target details. Justify the level of action recommended for each target.*

We recommend two targets that focus on protecting and rebuilding soil carbon:

**Target 1.** Reduce the annual conversion rate of grasslands by 75%.

**Target 2.** Invest at least $50M annually to support implementation of practices that help promote soil health principles and protect/rebuild carbon on grasslands.

To achieve these targets, it will be imperative to prioritize regionalized approaches that are intermittently re-evaluated. Equally imperative is re-evaluating the targets themselves over time to ensure they are creating the desired mitigation results with minimal trade-offs.

**SECTION 3.** **Pathways to reach the implementation target(s)**

*Highlight or recommend mechanisms needed to support the implementation target(s) generated above. Consider existing and new regulations, fees, taxes, market mechanisms, and incentive programs. As appropriate, distinguish between private and public mechanisms. Additionally, consider identifying key players (e.g., government agencies) or types of organizations that may be important to engage, although we suggest refraining from identifying specific organizations or individual names at this time.*

**Target 1.** Reduce the annual conversion rate of grasslands by 75%.

Pathways to achieve Target 1 should focus on supporting financial stability of ranching operations, given a considerable amount of grassland in California is grazed. Financial stability of ranchers helps ranchers maintain their ranch and reduces the need to sell land and/or convert management to more intensive agriculture or more intensive human development. However, many of the pathways can also support non-grazed grasslands as well, and those options are also important to consider. Pathways to help improve financial stability and reduce annual conversion include (Cameron et al. 2014):

* Conservation and agricultural easements
* Legislation that reduces property taxes through voluntary programs such as the Williamson Act
* Publicly funded voluntary conservation incentive programs akin to the USDA Grassland Reserve Program
* Land acquisition by state agencies or land trusts in areas under high threat of conversion
* Expansion of grazing on state lands (where ecologically beneficial) to help increase land access for lease options

**Target 2.** Invest at least $50M annually to support implementation of practices that help promote soil health principles and protect/rebuild carbon on grasslands.

Pathways to achieve Target 2 should focus on bolstering existing programs that focus on grantmaking and providing incentives to maintain existing carbon stocks and implement carbon sequestration practices. We also encourage pathways that leverage concurrent investments to restore wildlife habitat and water resources, since many practices provide joint benefits for water, wildlife, and the climate. Funds should include support for planning, supplies, infrastructure, technical assistance, and monitoring associated with implementation. Additionally, practices should be incentivized based on the latest science and should be regionally appropriate. In lieu of recommending specific practices, at this time we recommend the state *review and consider* the following practices: perennial plant establishment (via riparian restoration, re-establishment of native oak trees, windbreak and hedgerow plantings, and promotion of perennial grasses), soil amendments (e.g., compost addition), prescribed grazing (to minimize overgrazing and mitigate severe wildfires), and promotion of grassland cover and diversity (via range seeding or prescribed grazing).

Pathways to support investment in practice implementation include:

* Incentive-based voluntary stewardship programs such as CDFA’s Healthy Soils Program
* Traditional grantmaking through existing entities such as the California Department of Fish and Wildlife and the Wildlife Conservation Board
* Block grants awarded to conservation organizations and technical assistance providers for regranting and other implementation support. This includes Resource Conservation Districts and non-profit organizations.

Supporting the development of regional climate-smart markets will help to drive participation in these voluntary programs. Another critical enabling mechanism will be to fund research for an improved understanding of practice impact that can de-risk investment over time. Funding research on emerging technology and approaches that can help with practice implementation (including virtual fencing, inoculant-supported restoration of oaks, and compost procurement and application rates) will also be helpful, as will ensuring sufficient payment rates and levels of technical assistance are available for all practices and projects.

Improving or developing decision-support tools and frameworks that help spatially prioritize investments will also be critical to maximize benefits and minimize trade-offs. There are many approaches that could be used, but include bolstering NRCS Ecological Site Descriptions for grasslands statewide, developing high-resolution maps of soil carbon stocks that reveal opportunities for large gains via protection and restoration, and producing robust “soil health curves” for carbon by region and soil type.

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**AB 1757 Expert Advisory Committee**

**Proposed Targets for Wetlands and Blue Carbon**

**SECTION 1.** **Scope and Importance of Wetlands** [need to add more citations to this section]

Wetlands have aquatic and terrestrial characteristics, and they range from seagrasses, tidal and non-tidal wetlands to riparian wetlands, vernal pools and montane wetlands. Though small in area, wetlands are carbon (C) sinks and sources of GHG, and provide. The C density of wetlands soils is higher than any other land classification. Seaweeds may also act as significant carbon sinks, though research on this topic is still emerging.

In addition to GHG benefits, wetlands and seaweed habitats provide valuable ecosystem functions including habitat for birds, fish, and other wildlife. Wetlands provide many important hydrological benefits, including flood protection, groundwater recharge, shoreline protection and erosion reduction. They have a key role in nutrient cycles and fate of contaminants.

Loss of wetlands is primarily attributed to agricultural conversion and development, with California having the highest rate of wetland loss (90%) in the US. Wetland drainage leads to significant C and GHG emissions, as stored soil C is oxidized, as well as high rates of local subsidence (Deverel et al. 2020). Climate change poses a significant threat to wetlands, with shifts in precipitation and hydrology outcomes. Wetlands along the coast face flooding from potential sea-level rise. Some seaweed habitats have also declined across the state, facing numerous climate change-induced threats (e.g., McPherson et al. 2021).

Management and restoration provide many opportunities to restore C and reduce GHG. Conserving and restoring existing wetlands and seaweed habitats is critical to maximize co-benefits that cross cultural, environmental and social benefits.

**SECTION 2.** **Recommended Actions, Strategies, and Implementation targets**

1. **Improve upon existing acreage restoration targets for freshwater tidal wetlands in the Delta, saline and brackish tidal wetlands, and eelgrass meadows**
   1. *The current target of 60,000 acres in the Delta and Suisun Bay can be increased* by tidal wetland restoration targets (Delta Plan) and managed wetlands and rice cultivation.
   2. *Targets from related state efforts for tidal wetland restoration should be incorporated into emissions projections,* including for San Francisco Bay (Habitat Goals Project) and Southern California (So. Cal. Wetlands Recovery Project). Targets are needed for the central and north coast tidal wetlands..
   3. *Targets for eelgrass restoration within San Francisco Bay should also be incorporated* (Subtidal Habitat Goals), and additional acreage targets should be developed for other regions once progress has been made on recommendation number three.
2. **Prioritize conservation and restoration approaches that preserve and maximize existing carbon stocks and other wetlands ecosystem benefits for nature and people** 
   1. *Conservation of least-disturbed wetlands should be a first priority*, given that it has the potential to greatly reduce carbon emission and/or sustain on-going carbon sequestration, while ensuring persistence of other, hard-to-regain ecosystem benefits.
   2. *Use restoration approaches that maximize carbon sequestration benefits* (bearing in mind social risks and other ecosystem benefits) such as tidal reconnection, rewetting, and beneficial use of dredge sediment. Projects should also consider approaches that lead to diverse wetland and estuarine landscapes (e.g., restoration of both seagrass and neighboring tidal wetlands).
   3. *Use restoration approaches that address long-term resilience to future anthropogenic and climate stressors* (e.g., incorporating migration space)*.*
3. **Improve spatial data and existing knowledge gaps**
   1. Delta
      1. *Continue to improve emissions estimates for non-tidal and tidal wetlands in the Delta and Suisun Bay*, including rice fields, managed perennial and seasonal freshwater wetlands, and tidal wetlands.
   2. Brackish and salt marshes
      1. *Expand tidal wetland data acquisition and modeling to coastal systems beyond the San Francisco Estuary*. Most blue carbon research and modeling has been done in the San Francisco Bay-Delta, with less data from the southern California coast and even larger knowledge gaps for central and north coast wetlands.
      2. *Improve integrated modeling of sequestration and emissions for tidal wetlands*. Multiple models exist for carbon sequestration in tidal wetlands, but they are not linked to emissions. Integrating these models with spatial datasets will improve estimates of their potential in statewide carbon reduction.
   3. Seagrass
      1. *Make (at a minimum) a one-time effort to map all eelgrass in California. Subsequently, conduct monitoring (at a minimum) in the five bays containing the majority of the state’s eelgrass for areal coverage every 5 years.* There are currently limited statewide maps of eelgrass; mapping efforts are sparse in space (e.g., absent in some bays for decades) and time. This makes target setting and understanding the contribution of eelgrass to state climate resilience very difficult.
      2. *Support collection of California eelgrass carbon sequestration and emissions data,* which are sparse but increasing, and their incorporation into models to evaluate habitat-wide carbon sequestration.
      3. *Support investment and research in eelgrass restoration* (in implementation and development of habitat suitability models), which will need to expand to meet acreage targets.
   4. Seaweed
      1. *Determine the carbon sequestration potential of California kelp forests and nearshore algal beds.* The long-term C sequestration potential of macroalgae is unclear given it is presumed to largely occur far away from existing forests, in deep ocean sediments and as recalcitrant carbon in aqueous pools. Science to evaluate this potential will inform the role of seaweeds in California’s climate goals.
      2. *Improve understanding of kelp forest restoration approaches.* Given that efforts to restore California kelp forests following extreme loss are nascent, many gaps remain on the best approach, scalability and how to ensure efforts are successful and meet community needs. Improved mapping can also facilitate informed restoration and management decisions.
   5. Montane wetlands
      1. *Improve understanding of spatial variability and drivers of carbon dynamics in montane wetlands.* Alluvial wet meadows store inordinate amounts of carbon compared with surrounding uplands. More information is needed on the extent of these important regional carbon sinks on the impacts of forest management practices.
      2. *Develop maps of montane wetland distribution and condition across the state.*
      3. *Improve understanding of how montane wetlands interact with fire behavior and fire impacts to affect carbon storage both in the wetlands and in the forest.*

**SECTION 3.** **Pathways to Reach the Implementation Targets**

Eelgrass

Previous iterations of CARB’s scoping plans do not include eelgrass acreage targets. Other existing targets and data can inform target development, but will require support for development and implementation. A habitat suitability model developed for San Francisco Bay identifies a maximum potential eelgrass habitat area of 23,440 acres, with only about 3,000 acres of eelgrass currently present (Boyer and Wyllie-Echeverria, 2010), supporting goals to restore 3,000 to 6,000 more acres of eelgrass (Vaughn et al. 2022). Current efforts to restore SF Bay eelgrass have only achieved roughly 100 acres of restoration, given technical challenges, personnel requirements, and investment. Meeting acreage targets in the thousands of acres will require advances in restoration, requiring financial support and new science. Additionally, spatial data, suitability models, and basic monitoring do not exist, making verifiable regional or statewide targets difficult to set. Eelgrass mapping is challenging given they are not often visible from satellite platforms. Technological improvements (e.g., UAVs, side-scan sonar) in mapping making the recommended one-time comprehensive monitoring and 5-year site specific monitoring more feasible. The California Eelgrass Mitigation Policy and other state guidance documents can guide standard monitoring practices, and support from State and Federal agencies and partners such as the California Ocean Protection Council, the Southern California Coastal Water Research Project and NOAA can facilitate development and implementation of such efforts (NMFS, 2014). Lastly, even with sufficient monitoring and scalable restoration, additional scientific work is required to determine the impact restoration outcomes have on carbon reduction. For example, targeted investments could facilitate development of models tailored to state needs and filling the knowledge gaps identified above.

Seaweed

Seaweeds are unique in their carbon reduction role via export below the ocean mixed layer (Krause-Jensen Duarte, 2016). There is a dearth of information on seaweed limiting carbon management activities and merits funding to address the gaps ID’d above. Kelp forest restoration is also poorly understood, with a need to ID appropriate restoration approaches, particularly given the high spatiotemporal variability of kelps (Cavanaugh et al. 2019; Rogers-Bennet and Catton, 2019). Similar to seagrass, improvements in remote sensing makes monitoring these habitats more feasible, but with high species-specific variation. Programs to regularly monitor these habitats will be essential.

Tidal and Non-tidal Wetlands

Within the Delta, efforts are underway to restore wetland and introduce rice for subsidence reversal, with multiple projects underway or in planning with funding from the Sacramento-San Joaquin Delta Conservancy. Additional acreage could be achieved through this program with additional funding. The Delta Plan targets 30,000 acreage for subsidence reversal by 2030, and substantial additional opportunities could be leveraged by 2045 (Delta Plan, Chapter 4, Amended 2022:<https://deltacouncil.ca.gov/delta-plan/>). In addition to large benefits related to reduced CO2 emissions with reflooding of drained lands, subsidence reversal in these areas provides added benefits in reducing stress on levees and seepage (Deverel et al. 2020; Windham-Myers et al. 2023). Similarly the Delta Plan has set targets for tidal and floodplain restoration in the Delta and Suisun Marsh that exceed the Scoping Plan targets, with 32,500 acres of tidal wetlands, as well as even greater acreages of other wetland types in the region (see Appendix E, Performance Measure 4.16 for detail:<https://deltacouncil.ca.gov/delta-plan/>).

Large-scale efforts are underway for the restoration of tidal wetlands in San Francisco Bay, with the establishment of the San Francisco Bay Restoration Authority (<https://www.sfbayrestore.org/>) and multiple large projects, including the South Bay Salt Pond Restoration Project (<https://www.southbayrestoration.org/>). The Goals Project (1999, 2015) set long-term targets of 60,000 acres of tidal wetland restoration for the Bay but did not establish a temporal time frame for these targets. While most of the Bay restoration efforts have focused on habitat, flood protection, water quality, and public access, tidal wetlands do provide high rates of carbon sequestration (Drexler et al. 2009; Callaway et al. 2012). Recent research has focused on evaluating emissions and efforts are underway to integrate past models of soil carbon with emissions. For example, the MEM-PEPRMT model is currently being developed to incorporate these components (Mack et al. 2023). The Southern California Wetlands Recovery Project (2018) set regional goals for preservation, restoration, and future migration of coastal wetlands in southern California. While these goals are aspirational, they provide a basis for regional targets of acreage, sequestration, and emissions. The north and central coastal areas of the state lack regional goals; they would benefit from regional evaluations of restoration opportunities that could guide sequestration and emission targets.

Montane Wetlands

Montane wetlands are found on the slopes of Sierra Nevada and Coast range mountains. Their riparian soils contribute disproportionately to water retention and quality, forage production, and wildlife habitat. Human activity and grazing have led to the degraded state of these wetlands. The condition and extent of these wetlands is not well characterized with up to ⅔ of these wetlands losing half of their soil C (Norton et al. 2011). These wetlands should receive priority to restore soil C levels, water quantity and quality and other ecosystem services which will require funding to address the gaps identified above. Similar to kelp and seagrass, improvements in remote sensing will help in developing programs to restore and protect these wetlands.

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**AB 1757 Expert Advisory Committee**

**Proposed Targets for Forests**

**SECTION 1.** **Outline scope and importance of land sector**

Forests cover one third of the state --33M acres--and are responsible for the vast majority of its natural carbon sequestration, accounting for some85% of the state’s carbon stores. Forests, specifically conifer forests, are the largest and most expandable of the biological carbon sinks of the state.

Conifer Forests: California’s conifer forests are amongst the most biologically productive and diverse in the world, including coast redwood, ponderosa pine and mixed conifer. These forests are critical for both carbon and climate benefits, (adaptation and mitigation), watershed function and biodiversity conservation. Of the 24.5M acres of conifer forest, roughly half is in public, primarily federal, ownership. However, many of the most productive forests—those capable of the greatest carbon sequestration-- are in private ownership. There is a significant opportunity to increase resilient forest carbon stocks on private conifer forests, while public forests may remain relatively flat in stocks overall (Gray, Christensen, Kuegler FSEPRD895999, 2020). Key reasons for this are the relatively very young ages and homogeneity of these forest types, especially on private lands. These young, homogenous forests are highly susceptible to fire, pests and other climate stressors (Franklin, North personal communication +). These forests are capable of naturally higher and more resilient carbon stocks than found today. Of these, the industrially owned are generally intensively managed for timber products, and market forces drive harvests at ages well below the natural carbon potential. These are the most expandable carbon sinks of the natural and working land types and can account for the greatest gains through changes in management and investment. Significant increases are feasible by retaining these lands in production, but moving them to, on average, older age classes which hold more carbon and more natural forest conditions that are more fire resilient and tolerant, as these are all fire-adapted forests. Gains of +/-360 MMT CO2e are feasible in the next 10 years by changing forest management on under 2 million acres of these forests, while keeping them in production, managing for more fire resilience and resistance and conserving them as productive forests. Priority should be given to headwaters forests (FRAP 2017). This would also lead to significantly enhanced watershed function and reliability, major gains for biodiversity, reduced fire threats, leverage existing investments in fuels management and significantly enhance ecosystem function, all of which also promote adaptation within a changing climate. Currently, of the 6M acres of these privately owned conifer forests, less than 5% is conserved. There is thus great opportunity to both increase the carbon stocks and climate resilience of these forests while also addressing a suite of threats to them.

Riparian Forests: these are transitional zones between terrestrial and aquatic systems that exhibit characteristics of both systems. They are typically vegetated with lush growths of grasses, forbs, shrubs, and trees that are tolerant of periodic flooding and have sediments that are rich in nutrients and organic matter. Riparian systems look and function differently across the state but possess some common ecological and hydrological characteristics such as fish and wildlife habitat, water storage, flood control, nutrient cycling, water quality protection, recreational and economic benefits, including carbon sequestration – particularly in mature or in restored riparian zones. The primary literature shows that the establishment of riparian forest will more than triple the baseline, unforested soil carbon stock, and that riparian forests hold on average 68–158 Mg C/ha in biomass at maturity (Dybala et al. 2018). Recognizing the importance of these aspects, the California Riparian Habitat Conservation Program (CRHCP) to develop coordinated conservation efforts aimed at protecting and restoring California's riparian ecosystems was created by state legislation in 1991.

Oak Woodlands/ Forests: These forests are important to California due to their scenic, wildlife habitat, biodiversity, and cultural values as well as sequestering atmospheric carbon. With some estimates of oak woodland and forests at nearly 13 million acres (over five million hectares) of oak woodlands and mixed oak-conifer forests in California, these oak-related lands have sequestered over 325 million metric tons of carbon in live trees. Another 350 million metric tons of carbon are sequestered in understory vegetation, downed woody material, and soil horizons. Californian valley oak woodlands and savannas can be found in inland valleys and foothills throughout California, providing critical habitat for a diverse range of native plants and vertebrate species; these woodlands have been declining (Whipple et al. 2011). Because of their ecological and cultural significance, California's Valley oak woodlands and savannas are now being protected and restored at many sites within the species' historic range. In California, an estimated risk of losing 750,000 acres of oak forest and woodland (and subsequently, 33 million tons of sequestered carbon) by the year 2040 (Gaman 2008, Gaman and Firman 2006). Further, modeling efforts have found that climate change may favor oak species, at the expense of conifers (Coffield et al. 2021) – providing another incentive to invest in protection of oak forests and the habitats associated with them.

**SECTION 2.** **Recommended actions, strategies, and implementation target(s)**

*Describe the conservation and stewardship strategies that should underpin climate action in this land type. Draw from, but do not confine yourself to, the recommendations put forth by the Climate Smart Land Strategy, Climate Adaptation Strategy, and Climate Scoping Plan. Recall our guiding principles (defined above) as you generate this section.*

Conifer Forests: By 2034, conserve 40% of the most productive privately-owned conifer forest types at scale with working forest conservation easements that improve natural forest structure and function on managed private forestlands. This includes Sierran and Klamath Mixed Conifer, Redwood, Douglas Fir and Ponderosa Pine types. Pair this with restoration investments to, as applicable, reduce stand density and improve structure and composition, and re-introduce managed and controlled fires. Build on state investments to improve fire conditions across the landscape and ownership types.

*Target: increase C sequestration by 360MMT Co2e by conserving 2M acres of managed conifer forest by 2034, with priority for headwaters forests and for integration with fuels management.*

Riparian Forests: There are approximately 350,000 acres of riparian habitat in California, and of this 145,000 are riparian woodlands (Rohde et al. 2021). Protecting mature riparian habitats and restoring altered riparian forest ecosystems are two recommended actions to enhance carbon storage in addition to the widely recognized benefits of riparian habitat restoration including (improving water quality and flood water storage, (2) enhancing fish and wildlife habitat, and providing recreational opportunities such as wildlife viewing, fishing and hunting that supports local economies and public health. Actively planting riparian forest significantly accelerates the biomass carbon accumulation, with initial growth rates (in the first 10 years) more than double those of naturally regenerating riparian forest (Dybala et al. 2018). As such, increasing the frequency and scale of riparian forest restoration is a valuable investment providing both immediate carbon sequestration benefits and long‐term ecosystem service returns (Dybala et al. 2018).

*Target: Accelerate WCB CA Riparian Habitat Conservation Program to at least 2,000 acres/year target of riparian habitat, prioritizing projects that can include co-benefits, particularly for Oak species and also for desert or sparsely vegetated ecosystems.*

Oak Woodland and Forest: By 2034 prioritize and protect existing oak forest and replant oak woodland habitat in California to achieve desired densities and age structure targets. Although there is limited potential for large-scale restoration of complete valley-floor ecosystems, extant fragments do remain throughout much of California, particularly in the Sacramento/San Joaquin regions and it is possible that density and distribution patterns similar to the native oak woodlands and savannas could be strategically reintroduced within California valley floors (Whipple et al. 2011) at spatial patterns and range of historical oak densities of 2–30 trees/ha as well as set minimum densities or age structure targets. Valley oaks could be reintroduced in urban and residential areas as well as in surrounding rangelands at densities comparable to the native oak woodlands and savannas, thereby restoring aspects of ecologically and culturally significant ecosystems, including wildlife habitat and genetic connectivity within the landscape.

*Target: Conserve and restore the following oak woodland types and geographies: mixed-Oregon White Oak (Quercus garryana) and California black oak (Q. Kelloggii)- particularly in northwestern CA; Blue Oak/Blue Oak Pine habitats; replanting or “re-oaking” in Los Angeles/San Diego/Riverside/Orange counties.* Fire Management and Forest Restoration: California’s forest communities are all fire adapted. The current ARB Scoping Plan recommends fire and fuels management on 2.5M acres annually across all forests, shrub, and grasslands. This needs to be more regionally and land type specific, as some systems are more threatened by too much fire (coastal chapparal) and do not need proactive fuels management, while others suffer from too little fire (much of the mixed conifer regions). This approach needs to focus in on fuels management in mixed conifer forest, with the goal of expanding managed fire. It is likely that the large portion of annual acres treated will be fuels management (perhaps around 2 million acres). Equally, reforestation needs to be expanded in areas where intense fires have limited natural regeneration.

*Target: Maintain 2.5M acres goal, prioritizing up to 2M acres of mixed conifer annually for treatment across public and private lands and 500,000 acres for oak woodland areas moving to a majority of treatment with managed fire by 2030.*

**SECTION 3.** **Pathways to reach the implementation target(s)**

*Highlight or recommend mechanisms needed to support the implementation target(s) generated above. Consider existing and new regulations, fees, taxes, market mechanisms, and incentive programs. As appropriate, distinguish between private and public mechanisms and ownership contexts. Additionally, consider identifying key players (e.g., government agencies) or types of organizations that may be important to engage, although we suggest refraining from identifying specific organizations or individual names.*

Conifer Forests: Allocate minimum of $2B to achieve targeted C gains by a combination of:

• public funding-- commensurate to the net carbon reductions achieved as that for similar gains in other emissions sectors for acquisition of working forest conservation easements (WFCEs) that drive older, more resilient forests and enhance stocks,

• instituting tax credits for donated WFCEs and consider making these tradeable tax credits with other states (such as Colorado). An investment of $2B would result in an effective cost (averaged across these selected forest types) of under $35/T at 10 years, dropping to under $20/ton by year 20, and declining thereafter.

**Riparian:** Increase investment to WCB CA Riparian Habitat Conservation Program (CRHCP) for riparian easement and restoration opportunities. Development in riparian habitats should be avoided and riparian habitat restoration or conservation projects should prioritize those which can have co-benefits, particularly for oak species.

**Oak:** Serious consideration of county requirements for oak mitigation which is extremely variable and not shown to be effective in the maintenance of oak populations; Conservation options such as easements (or other equally effective habitat protection mechanisms) should be implemented and especially for Blue Oak types. Use of prescribed burns to improve restoration of understory communities and promote longevity of oak stands;

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California Forest Carbon Plan 2018

Appendix A. Use the following table to help guide your decision-making process for generating final targets. (Note: These tables are primarily to help identify and rank options)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Approach | Targets | Private conifer forests, industrial focus | Riparian Forest (Marion to lead) | Continue restoration public forests (Christy input) | Potential  Target D: Oak Forests |
| Strategy (a group of actions) underpinning this target | Increase average stand age,  Secure with WFCE, Improve NF condition across 40% | Revegetate and restore (replant, remove exotics) and conserve w/CE’s 25%? |  | Protect and restore oak woodlands through restoration, prescribed burning, and preservation; reconsideration of mitigation and CEQA or county requirements for oak mitigation |
| Objectives | Increase durable carbon storage | +++ | + | * (but should re-gain over time) | + |
| Mitigate other GHG emissions | + | 0, UNK |  | + |
| Promotes ecosystem function/adaptation to climate change | +++ | +++ |  | ++ |
| Reduce climate-change risks to human communities (e.g., catastrophic fires, floods, health) | +++ | ++ |  | + |
| Regulate water dynamics (e.g., groundwater recharge, flood risk) | +++ | ++ |  | + |
| Support biodiversity conservation (e.g., habitat, resilience, connectivity) | +++ | +++ |  | +++ |
| Intended benefit to marginalized, underserved, or frontline communities | ++ | +, UNK |  | +++ |
| Other co-benefits (e.g., reduce heat load, improve water quality, improve air quality, provide open space) | ++ | ++ |  | ++ |
| Promotes food production (and security) | 0 | + |  | ++ |
| Promotes job security | ++ | UNK |  | ++ |
| Leverages current investments | Yes | Yes |  | ++ |

**Effect sizes**

+++ = Highly beneficial

++ = Moderately beneficial

+ = Slightly beneficial

0 = Neutral effect

— = Slightly harmful

— — = Moderately harmful

— — — = Highly harmful

+/- = Trade-off between benefits and harms

UNK = Unknown effectiveness (unknown to the EAC)

For the final objective in the table, state yes or no.

**Certainty\*--This is a qualitative assessment.**

Very likely (90-100% probability) +++

Likely (66-100% probability)

About as likely as not (33 to 66% probability)

Unlikely (0-33% probability)

Very unlikely (0-10% probability)

\*Adapted from [IPCC guidelines](https://www.ipcc.ch/site/assets/uploads/2017/08/AR5_Uncertainty_Guidance_Note.pdf). Use expert judgment and discretion when determining a certainty level.

**AB 1757 Expert Advisory Committee**

**Proposed Targets for Shrublands**

# SECTION 1. Outline scope and importance of land sector

Shrublands occupy up to 32.9 million acres in California (CNRA 2022), as chaparral, coastal scrub, sagebrush steppe, and Mojave desert scrub (Barbour et al. 2007, Mooney and Zavaleta 2016). Shrub components are interwoven with other ecosystem types and can be transitional following forest fire. These varied shrublands have different characteristics, threats, and management needs. Threats to coastal sage scrub and chaparral include invasive species, high fire return intervals limiting recovery post-fire, and urban development (Cleland et al. 2016 and Parker et al. 2016). A major goal in these two

shrub ecosystems is to maintain existing stands. On the other hand, while urban development is a threat to northern coastal scrub, in some places northern coastal scrub should be controlled in order to maintain coastal prairie grasslands (Ford and Hayes 2007), which has been identified as a sensitive plant community (Ford and Hays 2007, CA Dept of Fish and Game, CA Coastal Conservancy). In areas with coastal prairie, maintaining disturbance to prevent type conversion to shrubland is important. Similarly, following fire in forested sites, shrubs can rapidly establish and maintain dominance for many years, depending on fire severity, site conditions, and tree legacies. While shrubs have historically been part of this heterogeneous and diverse fire-adapted landscape, it is the processes that produce a heterogeneous landscape that require conservation, not individual shrub patches.

In this document we focus our recommendations on coastal sage scrub and chaparral. Chaparral is the most abundant vegetation type in the state (Parker et al. 2016). In the future, the state should incorporate recommendations for all shrubland types.

# SECTION 2. Recommended actions, strategies, and implementation target(s)

Shrubland ecosystems are included in the scoping plan target to treat 2.3 M acres of forests, shrublands and grasslands per year, but many forest treatment types are not appropriate for shrublands and it is likely that treatments in shrublands will be much more limited in acreage than those in forests due to both opportunity and costs of treatment. Climate mitigation and resilience in shrublands should prioritize the following actions.

1. Address fire threats to shrubland ecosystems and adjacent human communities through fire ignition prevention programs and home/community hardening.
   1. Develop ignition prevention programs to address the largest sources of ignitions to avoid emissions from high frequency fire, habitat degradation and fire risk to communities.
   2. Provide education and funding (especially for low-income people in vulnerable communities) to retrofit homes/structures to make them more fire safe. Conduct defensible space training.
2. Smart growth, minimizing development impact to shrubland ecosystems.
   1. Humans are the number one cause of fires in shrubland ecosystems, increasing fire frequency, which reduces shrubland carbon stores and biodiversity.
   2. Shrubland ecosystems store carbon above and belowground and harbor endemic species.
3. Pursue conservation and restoration aligned with 30 x 30 for declining shrubland ecosystems, based on the best available climate change science.
   1. Important habitats for conservation include chaparral, serpentine chaparral, coastal sage scrub, and alkali sink scrub in non-forest regions across California.
   2. Seek opportunities for multi-benefit conservation and, where it is effective and beneficial, restoration.

# SECTION 3. Pathways to reach the implementation target(s)

**Pathway for Target 1:** Human communities within shrubland-dominated wildland-urban interface (WUI) zones require a community and regional scale approach to fire risk mitigation that includes multiple components (Moritz et al. 2022). This may involve novel strategies such as creation of well-maintained buffering land uses, reduction of flammable areas along key ignition pathways such as roadsides or powerline corridors, along with improvements in fire fighting and public safety infrastructure. Fuels treatments that promote grass invasion into shrublands can increase fire risk and should be avoided.

Ignition prevention should be a priority in shrubland WUI areas. Fire Wise Communities and Community Wildfire Protection Plans (CWPPs) can be successful avenues for education and change

around home hardening and defensible space. Fire Safe Councils, Prescribed Burn Associations, Resource Conservation Districts, among others may be able to develop and implement ignition prevention programs based on input from experts in the field. Funding for regional planning and low-income people in vulnerable areas to retrofit homes/structures is needed.

**Pathway for Target 2:** AB 1445 now requires counties and cities to consider wildfire risk and climate change in planning new housing development in long term general plans. Planners should consider shrubland fire regimes and risks, and how these may change with climate change in siting new development. Expanding beyond parcel-scale hazard reduction to larger scales is critical for both reducing shrubland fire ignitions by people, which is the largest source of ignitions, and for reducing fire risk to communities.

**Pathway for Target 3:** California’s shrublands harbor carbon above and belowground, as well as diverse, often endemic plant and animal species. Pathways to 30 x 30 identifies regionally specific shrubland habitats for conservation, including chaparral, serpentine chaparral, coastal sage scrub, and alkali sink scrub. A priority is to develop a conservation strategy for declining shrublands and shrub species. There are few data on shrubland carbon stocks and residence times in these varied ecosystems (Gonzalez et al. 2015, Bohlman et al. 2018), and just a few projections for effects of climate change, which primarily focus on the large shrubland area in Southern California (Malanson; Tauge et al. 2009, Underwood et al. 2019). Therefore conservation efforts should engage scientists to learn how shrubland species and ecosystems are expected to change, and prioritize conservation based on the best available science informed by climate change projections. In particular, there is a need to identify climate change refugia for at risk shrubland species.

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**AB 1757 Expert Advisory Committee**

**Proposed Targets for Developed Lands**

**SECTION 1.** **Land type scope and importance**

Developed lands, which include both urban and rural components, and make up 6% of California. Developed lands are defined as systems dominated by human development in the form of housing on small contiguous lots, industrial sites, and transportation corridors. Owing to our panels focus on ecosystem contributions to California’s climate adaptation and mitigation strategies, our focus is on the direct and indirect contributions urban greenspaces contribute to climate adaptation and mitigation. Developed lands contain a mixture of hardened development buildings and roads) intermixed with ecosystem elements that are the focus of other sections (e.g., forests, wetlands), elements found in but not the focus of other sections (e.g., riparian zones) and a suite of unique plant assemblages not considered elsewhere (e.g., lawns, street trees, parks).

Urban areas are defined as by the 2010 US Census as communities with a population exceeding 2,500[[1]](#footnote-1). In total, it is estimated that over 94% of Californians live in these developed areas. Thus, developed lands represent a suite of unique opportunities to have impacts directly on places where the vast majority of Californians live. Our attention to developed lands explicitly takes a dual focus. First, we address the impacts that developed lands have on climate (e.g., urban heat islands) and actions that can be taken through maintenance and restoration of urban greenspaces to directly reduce temperatures in developed lands and thereby reduce carbon impacts through reduced energy expenditures through air conditioning and travel choices.

Second, we address how developed lands may contribute to carbon sequestration. A major area of interest with respect to potential carbon sequestration are city trees. Opportunities for climate action arise from various existing programs, such as CalFire’s Urban Forest grants program and Greening Schoolyards programs, which significantly invest in activities aligned with the climate targets for developed lands. Emerging opportunities for increasing carbon storage emerges from federal urban greening programs as well.

These two factors, not surprisingly, interact. A principal benefit of urban vegetation is reducing the urban heat island effect. Urban trees contribute significantly to this effect. Numerous efforts associated with urban ecosystems, however, can reduce urban heat loads. Lawns, gardens, riparian corridors, wetlands and other green spaces (e.g., green roofs) cool urban environments and store carbon. As such, urban greening programs (stream daylighting programs, riparian restoration, green infrastructure, schoolyard gardens) all have potential to lead to indirect climate impacts by reducing energy usage among the approximately 36 million Californians living in developed areas.

Actions that mitigate energy usage and those that foster increased carbon sequestration face considerable challenges. Urban greenspace contributes to social benefit and counteract urban heat island effects, but also necessitate water for irrigation and can escalate wildfire risk. The effort to reduce urban water usage is driving urban areas toward xeriscaping and reducing the potential cooling effect that green vegetation has on urban environments. Increased drought stress and water limitations impede the potential for city greenspace to reduce urban heat effects and store carbon. In addition, the ongoing conversion of natural and working lands to developed lands typically diminishes carbon storage and sequestration potential on these newly developed lands. Critical uncertainties for potential climate mitigation revolve around the need to address key unknowns such as the capacity of stream daylighting on climate mitigation and carbon storage, the balance between fire risk and vegetation in small towns in high fire risk environments, and the strategic alignment of tree planting in under-served communities with climate mitigation and carbon storage.

Issues of social equity and environmental justice are front and center in all our considerations of managing greenspaces within developed lands to reduce energy usage and sequester additional carbon. More than most places in the world, the residential communities of California span an incredible range of annual cooling days and soil moisture water stress. Thus, there are environmentally-driven gradients in where a focus on either reducing urban emissions or increasing carbon storage is a greater or lesser benefit. These environmental gradients are not independent of gradients in socio-economic well-being. Strategies to reduce carbon emissions and increase carbon storage need to consider both the environmental gradients that create landscapes of greater and lesser opportunity alongside the socio-economic gradients that create landscapes of greater and lesser opportunity to increase social equity and redress past environmental injustices.

**SECTION 2.** **Recommended actions, strategies, and implementation target(s)**

Existing guidance from California’s NWL Climate Smart Lands Strategy and the CARB Scoping Plan offers a robust foundation for conservation and stewardship strategies in urban areas, emphasizing carbon storage, sequestration, and loss prevention. However, to maximize climate impact, certain actions must be prioritized, aligning with both the state's recommendations and our own assessment of crucial needs. We recommend prioritizing three targets to help meet California’s ambitious climate targets.

Target 1. Increase urban vegetation to decrease emissions. The specific target request is for California Resource Agencies to create a plausible estimate of the potential impact of the greening of urban ecosystems to reduce fossil fuel usage and emissions; conduct a cost benefit analysis of these climate benefits against the cost of increased urban water usage; and geospatially link estimates of benefits-costs in order to deploy reduced emission strategies in a manner that increases social equity and environmental justice.

*Rationale***:** We envision that, by far, the largest potential impact of the management of urban ecosystems on climate change is through avoided emissions by creating cooler more livable cities. Strategically fostering urban ecosystems can: (a) avoid emissions through reduced air conditioning by reducing urban heat island effects; and (b) avoid emissions by creating urban spaces where people will choose to recreate, rather than drive elsewhere.

* Urban vegetation can reduce urban heat island impacts and alter behaviors of people that would avoid significant carbon emissions.
  + Broadly foster green cities. Urban greening can be through gardens, yards, lawns, riparian vegetation and city trees.
  + Develop regionally appropriate plant selections suited to the respective climate and provide incentives for growers to stock appropriate plant material.
  + Cultivate technical assistance to develop and share local knowledge to conduct urban habitat restoration efforts and urban forest management.
* There are predictable social and geographical predictors of where the maximum benefits in avoided can be accrued.
  + Underserved communities are also the urban areas that are the most under-vegetated, where benefits may be greatest.
  + Underserved communities may have the lowest energy efficiency, where reducing urban heat islands can maximize avoided emissions.
  + Developed lands in the hottest portions of California (SE Deserts, Central Valley) are also some of the least the socio-economically least well off.
* There are significant challenges in efficiently deploying resources to help avoid emissions through vegetation.
  + Green vegetation requires water. Active programs to reduce water consumption in urban areas of California are working at odds with programs that would avoid emissions from urban areas

Target 2. Increase C sequestration target to 60 MMT CO2 by 2050.

*Rationale*. The CARB model suggests a potential to increase double urban carbon storage by approximately 30 MMT to 60 MMT CO2 by 2050. Progress toward this goal may be significant in the next 5-10 years, but as trees grow slowly, we see larger benefits closer to 2050. While substantial this carbon storage is small relative to statewide carbon pools, suggesting that co-benefits of urban trees need to be an essential, maybe the driving, rationale for programs to incentivize urban forests.

* We find that the CARB model may be an over-estimate of carbon stock potential because of factors that were not built into the model (and may be difficult to build into a model). These include:
  + Carbon stock estimates are based on street trees, whereas potential total stocks are based on all urban trees. Street trees, on average, are larger in stature than yard trees. Street trees are principally planted for shade. Yard trees are often smaller statured fruit trees and ornamental trees. We do not have an estimate of the magnitude of this effect given that there are not good inventories of yard trees, as there is for street trees.
  + Carbon stock estimates may be optimistic because urban trees gain most of their water from ancillary watering of yards. As California incentivizes xeriscaping and reduction of non-consumptive water uses, urban trees will become more stressed, accrue carbon more slowly, and die more quickly.
  + Carbon stock estimates are likely to be optimistic because changing climates requires planting climatically appropriate species. This will often require adaptation in planting stock, planting more drought tolerant species. There is evidence to suggest that nurseries that are supplying trees for urban planting are focusing on consumer interest and not long-term climatic suitability. Thus, we anticipate high potential rates of tree mortality, shorter than average tree life spans, and slower than average carbon accumulation amongst urban trees.
* Given the potential for water and heat stress on urban trees, we recommend the state foster professional development programs (akin to California Naturalist Program, Veterinary technicians or Certified Foresters) for licensed urban tree and vegetation management.
* Although CA and the Federal government incentive programs for urban trees have programs to engage underserved communities and direct resources toward these communities, we challenge the state to be proactive to seek out underserved communities and engage them in the difficult conversation about trade-offs of planting trees, water use efficiency and co-benefits of urban greenspace.

Target 3. Limit Expansion of the Developed Land Footprint. Focus future development in existing and peri-urban footprint-limit expansion through planning, permitting and direct conservation (reduces VMT, increases retention of C in intact natural and working lands). Efforts to limit growth may provide the greatest climate impacts in the near (5-10 year) term.

*Rationale*. California continues to expand developed lands onto other working and natural lands. These new developments result in increased carbon emissions both directly (reducing ecosystem carbon storage) and indirectly (e.g., increasing average commuter time).

* Developed lands have, on average lower carbon sequestering potential and higher carbon emission potential than most natural lands. Thus, as land is converted to developed lands, carbon stocks are increased.
* City and county planning is the primary means of directly growth of development on previously developed lands. We challenge the state to reduce growth incentives for cities and counties to reduce urban expansion.

**SECTION 3.** **Pathways to reach the implementation target(s)**

Target 1. Reducing carbon emissions on developed lands can be achieved through strategic use of funds designated to foster green infrastructure (e.g., roofing), schoolyard and urban gardens, and urban tree planting. Greening of urban areas needs to focus on climate and drought resilient native species: trees, shrubs and grasses (indirect C benefits, major climate benefits). Programs that Prioritize lower income/frontline communities.

Target 2. State and federal programs are pushing resources toward urban tree planting. These resources may pay for sufficient tree planting to reach the target. However, we see a major constraint in source material for planting low water, drought tolerant native species. We also see few resources going toward public information campaigns to explain the benefits of planting resilient trees.

Target 3. Primary pathways to reducing continued expansion of developed lands are principally twofold. County planning represent the front line of opportunity to plan for reduced urban expansion. The second pathway is through current challenges in the home insurance industry that may constrain the capacity for insuring new homes in the wildland – urban interface. There are numerous issues associated with state policies on county planning and insurance, but using these strategically to meet climate goals should be an objective.

**SECTION 4. Key Resources**

<https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_NatureintheUrbanCentury_FullReport.pdf>

<https://naturalcapitalproject.stanford.edu/projects/sustainable-livable-cities>

*Note: This is too long. We did not worry about that in this draft, but the final draft will be shorter.*

1. https://www.newgeography.com/content/007707-california-most-urban-and-densest-urban-state#:~:text=The%20urban%20areas%20of%20California,two%20Nevada%2C%20at%2094.1%25. [↑](#footnote-ref-1)