August 5, 2013

Shelby Livingston
Chief, Climate Change Program Planning and Management Branch
California Air Resources Board
1001 I Street
Sacramento, California 95814

Dear Ms. Livingston,

Our organizations appreciate the opportunity to submit the following recommendations to the California Air Resources Board outlining how working and natural lands can and should help California address climate change as part of the AB 32 Scoping Plan update. As CARB has noted at the recent Scoping Plan workshops, forests, rangelands/grasslands, urban forests, woodlands, and wetlands provide a tremendous opportunity within the natural resources sector to achieve significant GHG emission reduction goals. Our organizations have come together to provide these recommendations to further the state's goals of reducing GHG emissions while providing multiple environmental and health co-benefits in our urban and rural communities.

The attached sections provide background and specific climate policy recommendations related to forests, urban forests, wetlands and rangelands to inform the natural and working lands portion of the 2013 Scoping Plan update. While they are organized in discreet sections, we recognize that these sections and subsequent recommendations are inter-related, much like the sections and policies of the larger Scoping Plan. This overlap and inter-relationship is geographic, in part, as forests often include rangelands, wetland meadows and woodlands within them and may connect to urban forests. Many agricultural lands are interwoven with more natural grasslands, wetlands and forests, as well. The overlap also relates to policy, as natural and working lands underpin fuels and energy and also impact and can be impacted by transportation and land use. Thus, climate policies related to renewable energy and fuels and land use and transportation, among others, should acknowledge this synergy in spite of how the various Scoping Plan sections may ultimately be divided. In particular, the measures taken to address increase sequestration and reduce emissions from natural and working lands can help achieve other key state priorities to maintain and enhance water quality and security and reduce transportation related emissions.

In addition to the specific recommendations for natural and working lands in the following sections, we offer several recommendations below as general guiding principles that should apply to the Scoping Plan in its entirety:

- *ARB, in partnership with relevant agencies, should develop consistent methods to estimate and monitor GHG reductions and co-benefits of measures/policies across all sectors at multiple scales that are implemented as part of the Scoping Plan*

- *Policies that are adopted and implemented pursuant to the Scoping Plan should optimize public and environmental benefits, including water and air quality protection, climate risk reduction, fish and wildlife habitat preservation and job creation*

We look forward to being a partner with CARB in this process, and hope the staff and board find this document useful. If you have any questions regarding the recommendations, please contact one of us through the e-mails listed below.

Sincerely,

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Introduction

California is at the forefront of addressing climate change by reducing greenhouse gas (GHG) emissions through innovative policies. With the news that 2013 also marks the first year in human history that concentrations of carbon dioxide (CO2) hit 400 parts per million (ppm) in our planet's atmosphere, it's critical that California maintain its leadership. Engaging all sectors of California's economy is essential to meet the state's GHG reduction goals for 2020 and 2050, given the significant reductions and action that are needed to address this problem. Therefore, it is important to ensure that California's natural and working landscapes are a part of the state's scoping plan update and long-term solution to climate change.

On a global level, deforestation, forest degradation and land use change contribute approximately 15% of human-caused GHG emissions. When our landscapes are disturbed through unsustainable management or conversion, they often cause direct emissions to the atmosphere, contributing to global warming. At the same time, when they are conserved or managed more sustainably, they can sequester additional carbon from the atmosphere and reduce concentrations of GHGs – a feature that is unique to this sector. Thus, how we manage and conserve our landscapes have a direct impact on our climate. This is true not only globally and but in California as well. For instance, the California Department of Forestry and Fire Protection (CAL FIRE) estimates that California's forests sequester 30 million metric tons of carbon dioxide equivalents each year.[1] The US Forest Service estimates the state's 200 million urban trees add another 4.5 million metric tons to that figure.[2] Changes in management and restoration of tule in key areas of the Delta can produce a total sequestration benefit of about 14 metric tons of CO2e per acre in the Delta each year. Rangelands also add to the equation, storing more than a quarter of the state's carbon.[3]

Appropriate investments in our state's natural and working lands, coupled with sound science-based public policy, would reduce GHG emissions significantly. They would also concurrently achieve many other important public and environmental benefits, creating a more climate resilient California. These myriad benefits include the protection of water supply and quality, air quality, species habitat, recreation and jobs, and impact all California communities both urban and rural.

The following are recommendations to inform the state's Scoping Plan update. They outline specific policies and research needs s to meet the state's GHG reduction goals beyond 2020. Sections I and II outline specific ideas for forests and urban forests and sections III and IV outline recommendations for wetlands and grasslands/rangelands.

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[1] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."

[2] McPherson EG (2012) Statistical analysis of GHG reductions and energy conservation benefits from California's existing urban forests.

[3] Eviner, V. UC Davis. 2013. Presentation at CalCAN Summit. http://dl.dropboxusercontent.com/u/47968538/Valerie%20Eviner.pdf

I. Forests

California's forests should play a crucial role in meeting the state's 2050 goal of reducing GHG emissions by 80% compared to 1990 levels. Indeed, as it becomes increasingly difficult and expensive to make emission reductions in other sectors such as transportation and energy, the ability of forests to actually remove carbon from the atmosphere will become an invaluable pathway to achieve many millions of tons of CO2 emissions reductions.

Additionally, actions in the forest sector bring other societal benefits including watershed protection and enhancement to improve water security, facilitate adaptation for fish, wildlife and plants, and, importantly, create new and sustained employment in rural areas hard hit by the recent economic recession. Achieving these ancillary benefits helps achieve other important state goals, in addition to GHG reductions.

Though millions of acres of the state's forests have been permanently converted to other uses, California remains one third covered by forests. The state has the most diverse suite of forest types nationwide, and the most diverse conifer forests globally, as well as some of the highest carbon storage per acre globally. While all forest types are important for carbon sequestration, some have a greater capacity to absorb and store carbon than others.

This section outlines the opportunities that California's forested landscapes offer the state to help it meet its GHG reduction goals, with a focus on private forestlands.[4] They fall into four general categories:

- Increase secure forest carbon stocks in resilient forest ecosystems through restoration and conservation management.
- Decrease forest emissions by reducing forest loss and mitigating emissions
- Increasing the security and resilience of forests to maintain carbon sequestration and many other public benefits.

Background on California's forests and synergy with other "sectors"

Forests in California cover approximately one-third of the state (31,620,000 acres). Of this forestland,[5] approximately 55% is publically owned and the remainder is privately held.[6] Over 75% of the publically owned forestland is held by the US Forest Service (USFS), meaning that the USFS manages 42% of California's forests and 13% of California's total surface area. With respect to the extent of certain forest types in California: 19% of

[4] As AB 32 is a state law, these recommendations focus on forestlands within the state's jurisdiction. Furthermore, some of the greatest opportunities to increase carbon storage and reduce emissions exist on non-federal lands.

[5] For the purpose of this document, we refer to "forestland" as those lands that are defined by CalFIRE in the 2010 Forest and Rangeland Assessment as conifer forest, conifer woodland, hardwood forest and hardwood woodland.

[6] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment." Note that in a 2008 assessment of California's forestlands, the USFS came up with a figure of 60% public ownership of California forestland. We use the FRAP figures throughout this brief to ensure consistency. If you wish to consult the alternative USFS assessment, the title of their report is "California's Forest Resources, 2001 – 2005: Five-Year Forest Inventory and Analysis Report."

California's surface area is conifer forest (19,335,000 acres), 2% is conifer woodland (2,399,000 acres), 5% is hardwood forest (4,594,000 acres) and 5% is hardwood woodland (5,292,000 acres).[7]

California's forests are living landscapes that respond to a combination of ecological conditions, public policy and market forces. Over the last 200 years, some 15 million of acres of California forestland were deforested to serve a rapidly expanding population or converted to agricultural lands.[8] While some of these acres have been reforested over time, many forestlands have been permanently converted to other types of landscapes. For example, in 2003 CalFIRE estimated that 95% of California's historic riparian forests and woodlands have been permanently converted to other uses. The loss of forestlands often leads to direct emissions, as well as the loss of future sequestration that these forests would have otherwise provided.

There are many public benefits provided by forests that go beyond their ability to sequester CO2. These include water filtration and storage, habitat for valuable fish, plants and wildlife, potential for renewable energy, reduced transportation emissions, recreational opportunities and jobs in rural communities. Actions and investments that protect and improve forest conditions will therefore benefit other sectors covered by the Scoping Plan – particularly water and energy. Nearly 85% of California's average annual runoff comes from forested watersheds.[9] Forests are the first filters for the state's water, ensuring that it is of high quality for surface storage reservoirs that supply our agricultural fields and urban households. Forest meadows play a critical role in the state's water system, acting as sponges which collect water during wet periods and release it slowly during dry periods of the year. Restoring forest structure can significantly increase water yields as well, through capturing and retaining more snowfall.

On the energy front, California's forests can play a crucial role in meeting the state's renewable energy goals. Forest bioenergy is increasingly recognized as an important contributor to the RPS, and the fuels used for bioenergy can come from management activities that improve forest health and resiliency. Additionally, the protection of forests and open space, as part of a larger integrated land use plan, can also support more compact development and help reduce transportation-related emissions.

A Key Strategy to Store More Carbon:

Maintain intact and ecologically functional forest landscapes

Carbon sequestration occurs with a forest system, not just at the individual tree or stand level. The more stable and connective the forest, the more effectively it functions as a watershed, as wildlife habitat, and as a system to absorb and store (sequester) carbon. The more fragmented and disturbed the forest—as by conversion, roads, intensive harvest or uncharacteristic fires—the less stable and effective it is.

[7] FRAP 2003 Assessment: "Typical Conifer Forest habitats include Sierran and Klamath Mixed Conifer, while Juniper is a common habitat in Conifer Woodland. Typical Hardwood Forest and Hardwood Woodland habitats include Montane Hardwood and Blue Oak Woodland, respectively." P. 46.
[8] See generally McArthur ED and Ott JE, 1996. "Potential Natural Vegetation in the 17 Conterminous Western United States." Citing Kuchler, 1964 "Manual to accompany the map, potential natural vegetation of the coterminous United States." Spec. Publ. No. 36. New York: American Geographical Society, p. 116.
[9] *Supra* note 3 at 138.

Therefore, a key strategy in the Scoping Plan should be to secure and protect the forest landscape that provides the carbon sequestration. This can be done across millions of acres by conserving forests, particularly those owned by private landowners that are interwoven with public forests. In large areas across California, public forests exist within a matrix of private lands, and with ongoing, cumulative impacts of fragmentation, development and degradation, the overall stability and security of all the stored carbon is at risk as forest function declines.

Therefore, an initial target of the Scoping Plan should be to identify where the greatest total volume of carbon can be secured within forest types, and focus efforts there. Subsequent investment can be made to complement this core set of gains. Use of conservation easements that not only protect the existing forest base but also increase carbon stocks over time is a key tool to help achieve this. Furthermore, targeting conservation in forest areas where precipitation is projected to be stable or increase over the next few decades could strategically achieve another key goal—securing water supplies as climate change continues to decrease water yields elsewhere in the state.

Promote Forests as a "carbon sink":

Encourage greater carbon storage through changes in forest management

California's forests currently store approximately 5.1 billion tons of CO_2e.[10] While current sequestration benefits are significant, these forests have the potential to provide far greater climate benefits, which should be encouraged in the Scoping Plan. Properly managed, this stock could be almost doubled,[11] and serve as stable, resilient carbon sinks for hundreds and thousands of years. Depending on the forests type, these forests may store anywhere from 30-80 tons CO_2e/acre for hardwood forests to over 200 tons CO_2e/acre in conifer forests such as mixed conifer and redwood types.[12] Disaggregating that landscape number between the public and private forests shows the large majority of gain would be on private lands, with the older federal forests already well-stocked. Despite having far greater productivity, private forests store, on average, half of what public forests store, due to their young age.[13]

When considering the policies to enhance forests as a carbon sink, it is important to focus on those forests that are currently sequestering carbon well below their optimal annual yield or amount. Increasing the average age of forests vastly increases the carbon stocks while still yielding timber. This is true across all conifer types forests

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[10] Robards TA, 2010. "Current Forest and Woodland Carbon Storage and Flux in California: An Estimate for the 2010 Statewide Assessment."

[11] Hudiburg T, Law B, Turner DP, Campbell J, Donato D and Duane M, 2009. "Carbon dynamics of Oregon and Northern California forests and potential land-based carbon storage." *Ecological Applications*, 19(1): 163 – 180, 178 ("If forests were managed for maximum carbon sequestration total carbon stocks could theoretically double in the Coast Range, West Cascades, Sierra Nevada, and East Cascades and triple in the Klamath Mountains. Our results indicate that Oregon and California forests are at 54% of theoretical maximum levels… given the absence of stand replacing disturbance").

[12] Stewart W, Powers RF, McGown K, Chiono L, et al, 2011. "Potential Positive and Negative Environmental Impacts of Increased Woody Biomass Use for California." P. 35. PIER Publication # CEC-500-2011-036. Cites the following figures for tonnes per hectare of live tree biomass carbon: redwood = 258.4 (383 tonnes CO_2e/acre), canyon live oak = 81.1 (120 tonnes CO_2e/acre), and blue oak = 32.6 (48.5 tonnes CO_2e/acre). Apply the following formula to convert metric tons of carbon biomass per hectare to metric tons of CO_2e per acre: X metric tons per hectare * 3.7 = Y metric tons CO_2e per hectare. Y / 2.47105 = Z metric tons CO_2e per acre.

[13] *Id* at 10. Federal forests are not subject to state laws and policies, emphasizing the greater opportunity for the state scoping plan to effect change on private and non-federal lands.

from coastal Douglas fir/redwood to mixed conifer inland types. In a study of ponderosa pine in central Oregon, a stand of trees between 50 and 250 years old sequestered greater amounts of carbon per unit of land area than a stand roughly 15 years of age in 1978.[14] Implementing this strategy within the mixed conifer forests of northern California could similarly increase average carbon stocks by an estimated 70-100 tons CO2e/acre in the next 40 years.[15] With over two million acres of forest on which this could be carried out, the carbon gains in this region alone could exceed 140 million tons CO2e at the lower end of the range. This means that climate policies for private forestland owners should focus on management for older, more diverse forests.

Additional carbon could also be sequestered across the state through reforestation, or restoring forests that were historically under forest cover but were converted to other uses. A 2004 study commissioned by the California Energy Commission identified significant opportunity for forest restoration along the riparian areas of California's rivers.[16] Such restoration would not only sequester carbon more carbon but also help restore water quality and habitat for many fish and bird species.

Policy Recommendations for increased, resilient carbon storage on forestlands include:

- Acquire conservation easements on private forestlands (include working lands) to restore and maintain older, more diverse forests with increased carbon storage.
    - Identify areas of the state that present substantial opportunities to protect and increase carbon sequestration and also provide important co-benefits including securing the state's water supply, and enhancing adaptation opportunities. Focus and aggregate investments to achieve a landscape-scale impact on watersheds in the region and to maintain large functional ecosystems.
    - Funding for conservation easements should come from auction proceeds and any future bond funding

- Forest restoration/reforestation through the CA Forest Improvement Program
    - Prioritize investments based on significance of carbon sequestration opportunities, as well as impacts to climate adaptation readiness and other co-benefits such as fish and wildlife habitat.
    - Develop a mechanism to ensure that investments lead to enduring public benefits.

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[14] Anthoni PM, Unsworth MH, Law BE, et al, 2002. "Seasonal differences in carbon and water vapor exchange in young and old-growth ponderosa pine ecosystems." *Agricultural and Forest Meteorology*, 111: 203 – 222.

[15] The Pacific Forest Trust performed an analysis of the potential carbon stocking for a substantial acreage of representative commercially managed private forestland in northern California, and the results were in line with this range.

[16] Brown, S., A. Dushku, T. Pearson, D. Shoch, J. Winsten, S. Sweet, and J. Kadyszewski. 2004. Carbon Supply from Changes in Management of Forest, Range, and Agricultural Lands . Publication Number: 500-04-068F. Winrock International, for the California Energy Commission, PIER Energy-Related Environmental Research, March 2004. http://www.energy.ca.gov/reports/CEC-500-2004-068/CEC-500-2004-068F.PDF. *Please note the study uses the term afforestation instead of reforestation.*

Minimize forests as a source of emissions:

Reduce forest loss to reduce GHG emissions from forests

Projections of conversion of California forestlands to other uses indicate the potential for additional emissions and lost sequestration from California's forests, unless actions are taken to protect these landscapes. Barbour and Kueppers estimated that during the 1990s and early 2000s, forestland in California was being converted at a rate of at least 15,000 acres per year.[17] Spero et al estimated that over 30,000 acres were converted in the 1980'2s and 1990s. A study by The Nature Conservancy (Cameron et al. in review) of rangeland conversion (primarily hardwood woodlands, shrubs and grasslands) from 1984 to 2008 estimates that 20,130 acres per year were converted to other uses across 33 California counties.[18] Conversion of forestland is expected to continue as a 2003 CalFIRE study estimated that conversion would occur on 4 – 6% of conifer forest types and 12% of hardwood forests and woodlands between 2000 and 2040.[19]

Comparing the direct GHG emissions and lost sequestration capacity of converted forestlands with the estimated GHG benefits of California's high speed rail (HSR) project leads to striking results. The California HSR Authority recently advised the state that they believe HSR will reduce CO_2e emissions by 27.1 million to 44.9 million tons, cumulatively, by 2050.[20] Avoiding the conversion of 540,000 acres of forestland (assume 15,000 converted acres x 36 years) will lead to avoided emissions of nearly 70 million tons of CO_2e, cumulatively, by 2050.[21] And this can be done for a tiny fraction of the cost of HSR. The lost annual sequestration capacity of these 540,000 acres by 2050 would be over 400,000 tons CO_2e.[22]

Reducing and mitigating for this conversion would help California meet its GHG goals by 1) avoiding the direct GHG emissions caused by conversion of forestland; and 2) retaining the capacity of the state's forests to sequester carbon in the future.

Policy recommendations to reduce emissions from forest loss and degradation:

- Implement mitigation requirements for the climate impact of forest conversion as identified under CEQA
  - Update the state's CEQA guidelines to:
    - Add language specific to forest and other natural land conversion as a source of GHGs and lost sequestration in Section 15064.4
    - Revise Section 15126.4 subdivision (c) to reflect clear mitigation priorities and rigorous GHG accounting standards for any offsets

[17] Barbour E and Kueppers LM, 2011. "Conservation and management of ecological systems in a changing California."
[18] Cameron, D.R., J. Marty, R. Holland. In review. Patterns of protection and drivers of loss in California's rangeland ecosystems, 1984-2008.
[19] 2003 FRAP Assessment at 90.
[20] California High Speed Rail Authority, 2013. "Contribution of the High-Speed Rail Program to Reducing California's Greenhouse Gas Emission Levels." Available at: http://www.hsr.ca.gov/docs/about/legislative_affairs/HSR_Reducing_CA_GHG_Emissions_2013.pdf.
[21] Calculated using the EPA factor for forestland conversion to cropland – 129.51 metric tons of CO2e per acre.
[22] Using the net annual average sequestration capacity from Calfire-FRAP 2010 assessment of CO_2e for all forestlands. http://frap.fire.ca.gov/assessment/assessment2010/assessment2010.html

    - Include a question in Appendix G section VII regarding loss of sequestration capacity that may occur as a result of a project
- Evaluate the pressures and threats of conversion of forest and other resource lands statewide to prioritize the acquisition and use of conservation easements to avoid conversion.
- Improve and
- Improve and adopt land use policies to prevent and mitigate conversion and fragmentation of forest lands
  - Adopt policies such as zoning which would restrict such conversions
  - Ensure that SB 375 Sustainable Communities Strategies include protection of lands threatened with development
  - Support incentives for local land use policies like SB 375 and others that encourage better land use to reduce GHG emissions not only from transportation but also other interrelated issues such as development and open space

Building climate resiliency in forests –

A key to meeting GHG goals

Another source of high emissions and ecological disruption is uncharacteristically intense fires driven by the high fuel loads in California. California has a Mediterranean climate, but current fire regimes are higher and more frequent than some historical analyses suggest. More frequent droughts, excessive fuel buildup from past fire suppression, larger and more intense wildfires, rising temperatures, reduced snowpack and lower overall precipitation in some parts of the state will almost certainly diminish the range and health of California's forestlands – notably in more central and Southern California. Climate change is projected to lead to the loss of forest cover due to these factors[23], especially in the more southern, drier forest types. It will also expose forests to greater risk of wildfire; a risk exacerbated by ongoing rural sprawl.

Building a climate resilient forest essentially means giving it the capacity to adapt to rapidly changing climatic conditions as a living ecosystem. At a local scale, this means promoting forest stands that have more natural structure, species composition, and age distribution (i.e. older), with gap areas intermixed with clumps of multi-aged trees of different species. This forest structure reflects historic fire regimes in place throughout California's forestlands. It can be structurally recreated by management practices with the focus on ecological and climate outcomes, rather than short-term timber production.

Often referred to as forest restoration, this kind of management is increasingly recognized by both the state and federal government as an essential tool to improve forest health and reduce wildfire intensity. The products of this restoration can supply fuel for renewable energy facilities.

A vitally important climate benefit of well managed and conserved forests is adaptation for fish, wildlife and plants. Conserving key private forests that connect to federal forests will weave together a landscape with safe

[23] Lenihan JM, Drapek R, Bachelet D and Neilson RP, 2003. "Climate Change Effects on Vegetation Distribution, Carbon and Fire in California." *Ecological Applications*, 13: 1667-1681. Shaw MR, Pendleton L, Cameron DR, Morris B, Bachelet D, et al, 2011. "The impact of climate change on California's ecosystem services." *Climatic Change*, 109: 465-484.

habitat corridors for plants and animals to adapt to climate change. Plants and animals will seek to migrate as temperatures and precipitation levels rapidly change, and they will not recognize private/public lines separating different forest properties.[24] Strategically targeted and protected landscapes give them the best chance for survival.

Policy recommendations to build resiliency in forests and maintain climate benefits:

- Support state policies, including regulatory changes, insurance requirements and incentives, to encourage private landowners to manage for the desired resilient forest stands.
- Fund the Vegetation Management Program to help landowners restore natural fire regimes.
- Encourage the federal government to invest in public land management to restore millions of acres of unnaturally dense forest to a more ecologically appropriate condition.
- Reduce the social and economic conflict between humans and fire by encouraging state policies that reduce the risk of loss of life or property from fires:
    - Support programs that subsidize or otherwise encourage retrofitting of existing homes in fire prone areas to meet current wildland fire resistant best practices
- Support incentives for local land use policies, like SB 375 and others that encourage better land use to reduce GHG emissions not only from transportation but also other interrelated issues such as development, fire and open space.

Setting a GHG reduction goal and monitoring progress

Focusing on eliminating threats and seizing opportunities in California's highly productive forests the Scoping Plan should set an initial GHG target of increasing resilient carbon stocks on California's nonfederal lands by 25-50% by 2050. Comparable, indeed greater gains have been achieved on public forests in less time. This target should also focus on protecting the security of the state's key forested watersheds, achieving a synergistic climate benefit. Initial periodic targets should focus on gaining the greatest forest base for sequestration, while later years may yield greater annual amounts of carbon sequestration. The state should also undertake a process to refine this target over the next three years based on a spatial analysis that builds on the statewide inventory and identifies emissions threats and carbon sequestration opportunities across the landscape.[25]

Conclusion

Mitigating and avoiding emissions and increasing sequestration in the forest sector will be an indispensible aspect of meeting California's 2050 GHG reduction goals. Reducing greenhouse gas emissions from California to that degree will extremely difficult – fortunately increasing the carbon storage and resilience of our forests has the same atmospheric effect, while also achieving myriad valuable co-benefits. The benefits of forest carbon sequestration increase over time. To maximize the benefits for 2050, we should invest in reforestation,

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[24] Loarie SR, Carter BE, Hayhoe K, McMahon S, Moe R, et al, 2008. "Climate Change and the Future of California's Endemic Flora." *PLoS ONE*, 3: e2502.

[25] To refine the statewide target for forests, ARB in conjunction with the resources agency, should build off the GHG inventory update and conduct a spatial analysis to identify emissions threats and sequestration opportunities across the California landscape. Such an analysis would provide the basis for developing a more refined target for the forest sector as well as a strategic vision for targeting policies and monitoring progress over time.

conservation, and improved management as soon as possible, with ongoing investments in improving forest resilience.

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II. Urban Forests

Introduction

Urban forests are the central component of the natural resource landscape in California's urban environment. As is further detailed in this document our residents – especially those living in the state's most disadvantaged communities – rely on urban forests to deliver GHG emission reductions while also providing key health, safety, economic and environmental co-benefits. Urban forests also induce non-motorized travel and are often the primary conduit to connect urban dwellers to nature. And although the California Air Resources Board has adopted a tree planting project protocol for fungible offsets, its official statewide estimate of GHG emissions and sinks does not include urban forests. This is a missed opportunity that should be addressed in the 2013 Scoping Plan.

Background

Urban areas in California encompass five percent of the state's total land and support nearly 95 percent of its population. According to the US Forest Service, California's 2.1 million hectares of urban land also support approximately 200 million trees of varying size and species.[26] CAL FIRE's 2010 Forest and Resource Assessment Program Report notes about 217,000 urban acres have been identified as densely populated with substantial existing tree canopy assets.[27]

Approximately 80% of the state's urban forest exists on private property – primarily on residential lots. Though these trees are often ornamental, the sheer quantity of trees and shrubs sequestering carbon on private urban property contributes significantly to overall figures. The remaining 20% occur on public property – primarily within local parks, schools, and along our city's streetscapes. This is California's large canopy urban forest – trees that, under optimum conditions, are properly managed and cared for by local governments and municipalities, with support and technical assistance from CAL FIRE.

Combined, these 200 million trees sequester approximately 4.5 million metric tons of CO_2 each year. An additional 1.8 million metric tons of CO_2 emissions are avoided from effects of these trees on home heating and cooling energy use through shade, lower summer air temperatures and wind speed reductions.[28]

Opportunities to Enhance California's Urban Forests as a Carbon Sink

A 2012 study helmed by Dr. Gregory McPherson of the USDA Forest Service Pacific Southwest Research Station in Davis took a new approach to quantifying and mapping CO_2 stored, sequestered and emissions avoided by urban forests in Los Angeles and Sacramento. After applying the average storage density (43.2 t per hectare tree canopy), sequestration (2.4 t) and avoided emissions (1.6 t) rates from this study to the state's 2.1 million ha of urban land, urban forests were estimated to store, sequester and avoid carbon emissions of 92.0, 5.3 and 3.4 million t, respectively. These values are slightly higher than reported earlier, perhaps reflecting higher avoided

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[26] McPherson EG (2012) Statistical analysis of GHG reductions and energy conservation benefits from California's existing urban forests

[27] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."

[28] McPherson EG (2012) Statistical analysis of GHG reductions and energy conservation benefits from California's existing urban forests

emissions from larger cooling loads for Sacramento and LA than statewide average, as coastal cities have lower air conditioning usage.

By way of comparison, trees in California's 12.4 million ha of forest land were estimated to store and sequester 4,451 and 38.6 million t of CO_2, respectively. Hence, urban forests are estimated to account for 2 and 12 percent of total CO_2 stored and sequestered annually by trees in California. If avoided emissions are included, urban forests are responsible for 20 percent of total reductions.[29]

Opportunities exist now to build on these numbers and the accompanying GHG reduction benefits by focusing on essential strategies to properly manage and maintain our existing urban forest, increase carbon storage through more urban tree planting, and reduce the vulnerability of urban forests to climate change impacts.

1. *Proper Management of Existing Urban Forest*

The majority of California's 200 million urban trees can store and sequester carbon through the 21st century if properly cared for and maintained. As local governments and municipalities are largely responsible for the care and management of our public land urban forests, they will need to be leaders in adopting local ordinances that encourage best management practices, while also promoting policies that preserve our precious heritage trees. Furthermore, they can help guide private tree care and plantings by providing education and support to residents; and partnering with local nonprofit urban forestry groups to demonstrate proper tree care techniques and appropriate species selection and placement.

Case Study: The Sacramento Shade Tree Program

The Sacramento Shade Tree Program is a Sacramento Municipal Utility District (SMUD) initiative that delivers shade trees to SMUD customers with the goal of reducing energy consumption and delivering other non-energy saving benefits. The program primarily targets the 370,000 single-family residences in Sacramento though all of SMUD's 600,000 customers, including multi-family residential, commercial and industrial customers, are eligible.

The program is executed in collaboration with the Sacramento Tree Foundation (STF), a local non-profit, whose community foresters help residents with tree selection, technical assistance, and tree placement for maximum energy savings. Participants agree to plant the trees in the locations specified by the forester and to maintain the trees according to given guidelines. SMUD pays for 100% of STF labor cost and tree purchases, and maintains monitoring and inspection responsibilities.

Residents are also able to use a web-based tool to calculate the amount of energy they are saving and the amount of carbon removed.

The Program also provides technical assistance on tree planting and maintenance, all free of charge.

Source: The Nature Conservancy

2. *Increase Carbon Storage through More Tree Planting*

California has the potential to increase its urban tree inventory by more than 20% over the next 40 years. A 2003 Study conducted by the US Forest Service concluded that there are 242 million vacant sites in urban areas that could support tree planting. Assuming some of those sites have been developed over the last decade, and perhaps several million more are not necessarily conducive to tree planting (i.e. soccer fields, compact street medians), we can still postulate that at least a third or more of these sites remain available. Every 10 million new urban trees planted and matured has the potential to increase GHG reductions by 225,000 metric tons each year.

[29] McPherson, E.G., Xiao, Q., and Aguaron, E. In Review. "A new approach to quantify and map carbon stored, sequestered and emissions avoided by urban forests in Los Angeles and Sacramento, California". Landscape and Urban Planning.

3. Reduce Urban Forest Vulnerability

Urban forests face a host of natural and man-made threats, many of which are closely connected to the Earth's changing climate conditions. The U.S. Forest Service reports in a recent study that tree cover in the country's urban areas is decreasing by 4-million trees a year. Though no research has been done on tree loss throughout California, the study reported a one-percent decline in trees and shrubs in Los Angeles despite the success of the city's Million Trees LA campaign.[30]

Outside the state, we've seen the devastating impacts of Superstorm Sandy and its effects on urban trees in New York City and large areas of New Jersey. We've witnessed floods that inundated large swaths of Australia. And we've watched rising seas affecting millions around the world. California's urban forest is susceptible to these same natural events, and much more. Small storm events like those that hit the Los Angeles area in 2011 downed countless trees in Pasadena; and record-setting heat waves such as those that scorched the Golden State earlier this month will further impact our trees and plants.

In addition, California continues to combat invasive species and imported pests like the shot hole borer. This small beetle drills into trees and brings with it a fungus that is planted in bored galleries under the bark where larvae thrive, hatch, eat, breed and repeat the cycle by carrying the fungus to other trees.
The pest originated in South East Asia or Africa, but now has an increasing presence in southern California.[31]

Tree diseases such as Sudden Oak Disease (SOD) continue to have devastating effects on the state's oak population particularly in coastal zones north of Monterey. A report published this in July, 2013 by the California Oak Mortality Task Force asserts California's 2012 SOD mortality levels were the highest since 2007 and elevated mortality levels continue into 2013 (with approximately 257,000 trees killed across 39,600 acres to date this year).[32]

Capturing Co-benefits as part of the Urban Forest Equation

The 2013 Scoping Plan explicitly seeks to assess the valuation of non-market ecosystem services across the natural resources sector. Since there are some up-front costs in planting and establishing urban trees, it is critical to monetize their long-term value in terms of human health and environmental quality. No other natural resource offers the broad scope of social, economic and ecosystem services (e.g. "co-benefits") that urban forests provide to such a large percentage of the state's population[33].

In hot, dry climates, shade from trees can cut energy use for cooling by 30%.[34] In fact, the cooling power of California's existing urban trees lowers the state's energy consumption by about 7,300 GWh each year, which is equivalent to more than seven 100-megawatt power plants.[35] In addition, by serving as a wind buffer, urban and community forests can save 10-25 percent in energy used for heating.[36]

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[30] Nowak, David J., Greenfield, Eric J. 2012. "Tree and impervious cover change in U.S. cities." *Urban Forestry and Urban Greening.*

[31] R. Stouthamer, P. Rugman-Jones, A. Eskalen, A. Gonzalez, G. Arakelian, D. Hodel, S. Drill. Pest and Diseases of Southern California Oaks. http://ucanr.edu/sites/socaloakpests/Polyphagous_Shot_Hole_Borer/

[32] California Oak Mortality Task Force. "Sudden oak death (SOD) continues to be the primary cause of tree mortality in coastal California." California Oak Mortality Task Force July 2013 Report

[33] California ReLeaf. 2013. "Why Trees."

[34] US Forest Service. 1990. Forestry Report R8-FR 17

[35] McPherson, E.G. and J.R. Simpson. 2003. "Potential energy savings in buildings by an urban tree planting programme in California". Urban Forestry and Urban Greening

[36] US Forest Service. 1990. Forestry Report R8-FR 17

Urban and community forests can conserve water, improve water quality, reduce storm water runoff, and increase local water supply. Water related energy use consumes roughly 19% of the state's electricity. Investments in green infrastructure like trees reduce energy consumption and associated water use. Urban forests also intercept rainfall and provide flood attenuation benefits, which are anticipated to be increased in need for climate readiness. By capturing rainfall on leaves and branches, and reducing the volume and rate of storm water runoff, fewer contaminants are transported into receiving water bodies. One hundred mature trees intercept approximately 250,000 gallons of rainwater per year.[37] The soil that supports trees can serve as a natural reservoir and bio-filtration system that treats and stores polluted runoff.

Finally, urban greening, local parks and community forests contribute to human health and well-being. They are highlighted in the Depart of Public Health's Obesity Prevention Plan and Health in all Polices report because they create a desirable environment for outdoor physical activity; reduce symptoms or incidence of attention deficit disorder, asthma, and stress; reduce exposure to UV radiation; and create a setting for neighbors to interact, strengthen social ties and create more peaceful and less violent communities.
The tools for attaching monetary value to each of these green infrastructure services exist now in several configurations. American Forests' *Urban Forest Assessments Resource Guide* offers more details on some the existing tools.[38]

Social Equity and Sustainable Community Strategies

The 2013 Scoping 2050 Vision Outline cites disadvantaged communities (or communities of opportunity) as an issue area to be addressed within the overall natural resources sector.

Disproportionately low-income and disadvantaged communities are commonly connected to those areas of California with alarmingly high levels of air pollution and elevated summertime air temperatures (e.g., urban heat island effect). These communities often have less access to the decision-making process, and have seen delays in GHG-reduction investments as mandated by state statute [cite 535 in code]. Each of these disproportionate impacts, when examined individually, can be addressed *to a certain degree* through urban forestry, as follows:

a. Air Pollution and Ground Ozone

A 2013 American Lung Association report provides California with the dubious distinction of capturing the top 6 spots among the worst air polluted cities in the nation. Particulate matter (PM) in the air is one contributing factor, and recent studies have indicated that the PM 2.5 is considerably more dangerous than previously thought. According to the American Lung Association, researchers at Harvard University and the California Air Resources Board (ARB) have tripled their estimates of the number of deaths that occur each year from particulate matter[39].

Ground level ozone is also a serious pollutant in these urban areas, and is formed by chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs) in the presence of sunlight and heat. For 2005–2007, 36 counties in California did not meet ozone standards according to EPA ozone measurements.[40]

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[37] City of Bainbridge Island – Community Forest Commission. 2010. Community Forests Best Management Practices Manual
[38] American Forests. *Urban Forest Assessments Resource Guide*
[39] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."
[40] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."

Not surprisingly, the Office of Environmental Health Hazard Assessment has identified all of these top 6 cities as being within the top 10 percent of the state's disadvantaged communities.

People at Risk In 25 U.S. Cities Most Polluted by Short-term Particle Pollution (24-hour $PM_{2.5}$)

2013 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]
1	Bakersfield-Delano, CA	851,710	254,658	77,793	18,232	50,187	25,296	167,656	44,022	200,571
2	Fresno-Madera, CA	1,095,829	321,487	114,718	23,016	65,120	33,800	224,505	59,435	272,942
3	Hanford-Corcoran, CA	153,765	42,382	12,366	3,034	9,354	4,504	29,646	7,656	27,949
4	Los Angeles-Long Beach-Riverside, CA	18,081,569	4,542,151	2,021,451	325,187	1,139,030	597,808	3,983,369	1,059,886	3,038,607
5	Modesto, CA	518,522	146,498	56,563	10,488	31,303	16,547	110,394	29,447	119,325

People at Risk In 25 U.S. Cities Most Polluted by Year-Round Particle Pollution (Annual $PM_{2.5}$)

2013 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Diabetes[9]	Poverty[10]
1	Bakersfield-Delano, CA	851,710	254,658	77,793	18,232	50,187	25,296	167,656	44,022	200,571
1	Merced, CA	259,898	80,991	25,034	5,798	15,039	7,658	50,722	13,340	68,371
3	Fresno-Madera, CA	1,095,829	321,487	114,718	23,016	65,120	33,800	224,505	59,435	272,942
4	Hanford-Corcoran, CA	153,765	42,382	12,366	3,034	9,354	4,504	29,646	7,656	27,949
4	Los Angeles-Long Beach-Riverside, CA	18,081,569	4,542,151	2,021,451	325,187	1,139,030	597,808	3,983,369	1,059,886	3,038,607
6	Modesto, CA	518,522	146,498	56,563	10,488	31,303	16,547	110,394	29,447	119,325
7	Visalia-Porterville, CA	449,253	145,232	43,101	10,398	25,559	13,075	86,663	22,830	113,766

People at Risk In 25 Most Ozone-Polluted Cities

2013 Rank[1]	Metropolitan Statistical Areas	Total Population[2]	Under 18[3]	65 and Over[3]	Pediatric Asthma[4,6]	Adult Asthma[5,6]	COPD[7]	CV Disease[8]	Poverty[9]
1	Los Angeles-Long Beach-Riverside, CA	18,081,569	4,542,151	2,021,451	325,187	1,139,030	597,808	3,983,369	3,038,607
2	Visalia-Porterville, CA	449,253	145,232	43,101	10,398	25,559	13,075	86,663	113,766
3	Bakersfield-Delano, CA	851,710	254,658	77,793	18,232	50,187	25,296	167,656	200,571
4	Fresno-Madera, CA	1,095,829	321,487	114,718	23,016	65,120	33,800	224,505	272,942
5	Hanford-Corcoran, CA	153,765	42,382	12,366	3,034	9,354	4,504	29,646	27,949
6	Sacramento—Arden-Arcade—Yuba City, CA-NV	2,489,230	606,325	319,042	43,295	158,254	88,544	586,151	386,342

Data Source: American Lung Association. *State of the Air 2013*

b. Urban Heat Island Effect

Impervious surfaces, such as asphalt, concrete and roof surfaces, contribute to urban heat islands and elevated air temperatures via their high heat capacity, thermal conductivity, and often low reflectance solar radiation. Relative to vegetation and soil, impervious surfaces are associated with low levels of evapotranspirational cooling. Fine-scale, remotely sensed data has shown that impervious surfaces are important predictors of intraurban variation in temperature and the degree of impervious surfaces generally increases with population density [EHP report]. Within cities, temperatures can vary by as much as 14 degrees Fahrenheit between green spaces with plants and trees and high rises encircled with concrete and asphalt.[41]

Several studies have found that the extent of impervious surfaces is greater in neighborhoods with low socioeconomic status and a high proportion of minority residents (although these studies have been limited to a single U.S. city or state).[42] Additional studies have documented racial/ethnic disparities in urban tree canopy, usually in the direction of racial/ethnic minorities living in neighborhoods with lower tree coverage. As an example, a study on canopy cover in Los Angeles by the US Forest Service demonstrated that affluent neighborhoods like Bel Air and Studio City enjoy tree canopy exceeding 40%, while it was as low as 7 to 10% in neighborhoods like south central and south east LA.[43] American Forests, the nation's oldest nonprofit citizens' conservation organization, recommends an average 25 percent tree canopy for the dry west. Specifically, 18 percent tree canopy goal for urban residential, 35 percent suburban residential and nine percent commercial.[44]

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[41] Irfan, Umair. June, 2013. "Learning from the Past, CDC Prepares for More Heat Waves." ClimateWire, E&E Publishing.

[42] Jesdale, Bill M., Morello-Frosch, Rachel, Cuching, Lara. July, 2013. "The Racial/Ethnic Distribution of Heat Risk-Related Land Cover in Relation to Residential Segregation". Environmental Health Perspectives

[43] McPherson EG, Simpson JR, Qingfu Xiao, Chunxia Wu. 2011. "Million trees Los Angeles canopy cover and benefit assessment." Landscape and Urban Planning. 99: 40-50

[44] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."

Increasing canopy cover through creating and sustaining urban forests and green infrastructure can mitigate the adverse impacts of air pollution and urban heat islands on human health and environmental quality by cooling urban heat islands, reducing energy use and filtering pollutants from the air.

Efforts to expand the urban forest can begin by communities setting individual tree canopy goals and striving to meet them through tree preservation and planting. Planned events such as California Arbor Week, a Tree City USA campaign and small grants administered by state agencies and statewide nonprofits attract participation of local residents.

While disadvantaged communities must be addressed in the 2013 Scoping Plan, so should Sustainable Communities Strategies (SCS) and the goals of Senate Bill 375. Close to 28 percent of the state's population (9.5 million people) live in high threat areas for air quality and urban heat.[45] With appropriate incentives and tools, the implementation of Senate Bill 375 and (SCS) can reduce such threats, and optimize GHG reductions not only from transportation but also from natural resource protection, including urban forests. But, up-front integration is key to success.

For example, development without guidelines to conserve urban forests leads to decreased natural resources, and the increasing potential for urban heat islands, air pollution and increased storm water flow associated with decreased water quality. Specifically, increase in the area of impervious surface due to new roadways and building hardscapes creates more water runoff, higher peak flows, soil erosion, and thermal hotspots. Grading activities in conjunction with new development amplify the issue.

Smart growth strategies at the outset with opportunities for expansion of the urban forest can support other planning goals. Modifying traditionally impervious surfaces with pervious pavers and bioswales in parking lots, planting trees along road medians, and adding green space above and adjacent to structures (i.e., green roofs, parks) can reduce storm water runoff and the urban heat island effect. As outdated urban areas and infrastructures are renovated and improved, they can be retrofitted to accommodate large-stature trees to maximize benefits. Vegetation barriers along freeways s can become green walls that filter pollutants and noise[46].

Urban forestry as part of an SCS can sequester additional carbon and reduce energy demand and related emissions, as stated earlier in this document. To optimize these climate benefits, the integration of these natural resource protection efforts with land use plans and practices is critical. Such integration will not only leverage GHG reductions, but they will maximize many public benefits for all Californians.[47]

Barriers to Success

Urban forestry comes with some up-front costs and the need for investment in tree care. As is the case with virtually all natural resource priority projects in California, fiscal demands outweigh fiscal realities. In the case of urban forestry, those fiscal barriers are the primary challenge we face in urban forestry in the following ways:

1. Public financing exhausted. Water and natural resource bonds have supported urban forestry at the state level for more than a decade. This support has translated into annual appropriations to CAL FIRE in the state budget of anywhere from $2 million at the low end, to a little over $7 million at its peak for local assistance grants that support on-the-ground urban forestry. These projects dollars have certainly helped

[45] Ibid

[46] California Department of Forestry and Fire Protection: Forest and Resource Assessment Program, 2010. "California's Forests and Rangelands: 2010 Assessment."

[47] Passero, M. March, 2013. Written comments to CARB on Investment principles and key investments in natural resource protection to reduce GHG emissions.

keep urban forestry alive, but even in the one year when $7 million was available, demand in terms of grant applications exceeded $25 million. Mechanisms to continue public financing and further explore private financing for urban forestry will be critical over the next several years.

2. CARB Urban Forest Offset Protocols. Since CARB adopted the protocol in 2011 only one project has been approved for eligibility. The primary reason for this is simple: the economics are unfavorable for urban forestry projects. From requirements for 100-year permanence to the monitoring, transaction, and reporting costs, the protocol create a structure in which only a fraction of the project costs are covered through offset revenues with credits selling at current market values. The Climate Action Reserve is currently revising the protocol to expand participation, reduce costs and increase revenues from carbon stored by existing as well as planted trees. CARB will need to play an essential role by evaluating their recommendations and approving appropriate adjustments to its compliance protocol.

3. Devaluation of Urban Forests at the Local Level

As is often the case when general funds suffer major decreases, many cities have looked to their parks and public works departments in the last several years to deliver cost-savings through natural resources budget cuts. Consequently, as cities continue grappling with a challenging economy, they are requiring property owners to care for trees growing along city streets (San Francisco began a seven-year process to turn over responsibility for 23,700 street trees to its residents in January, 2012[48]).

Case Study: San Jose Assessment Project

A March 2013 study inventoried and assessed San Jose's 1.6 million-tree urban forest, and reached the following conclusion:

The asset value of San Jose's existing urban forest is $5.7 billion, or $3,634 per tree.

San Jose's urban forest produces ecosystem services and property value increases valued at $239.3 million annually. The largest benefit, $154.6 million, is for increased property values and other intangible services. Building shade and air temperature decreases from trees reduce residential air condition demand by 415,000 MWh, saving $77 million in cooling costs each year. The existing urban forest intercepts 1.2 billion gallons of rainfall annually, which reduces storm water runoff management costs valued at $6.7 million. If carbon dioxide sequestered and emissions avoided from cooling savings by the existing trees, a total of 100,181 tons, were sold at $10 per ton, the revenue would be $1 million.

Source: *Urban Forest Inventory and Assessment Pilot Project*

California's challenge is to demonstrate to these local agencies the short-sightedness of this action, and the long-term gains across multiple sectors for maintaining and augmenting urban forests. Case studies such as the one completed in San Jose can help shape that discussion and monetize their value (see sidebar).[49]

Data and metrics from this study and others, if applied at a statewide level, and when coupled with the impressive job creation components of urban forestry [50] can transform the way we value urban forestry, and properly frame it in the range of local level social service priorities.

4. Cap and Trade Revenue Expenditure Implementation Delays. Starting in 2012, and continuing through May 13, 2013 of this year, CARB, Finance, the Legislature, and the Administration all participated in a well-vetted and lengthy process to develop an implementation plan for the expenditure of cap and trade

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[48] Wildermuth, John. January, 2012. "S.F. begins turning tree care over to residents." San Francisco Chronicle.

[49] Xiao, Qingfu, Bartens, Julia, Wu, Chelsea, McPherson, Greg, Simpson, James, O'Neill-Dunne, Jarlath. March 25, 2013. Urban Forest Inventory and Assessment Pilot Project Phase Two Report (Executive Summary).

[50] California ReLeaf. 2012. Trees and Jobs.

revenues with a very clear intent and indication to stakeholders and all Californians that funds generated from the auctions in 2012 and 2013 would be available *this year* for projects that reduce GHG emissions. The decision by the Administration to loan these dollars to the General Fund created an unnecessary delay in moving California forward on this aspect of AB 32 and demonstrating to skeptics that we were ready to take this step. On the same week that we learned our planet's atmosphere had reached 400 parts per million (ppm) in concentrations of Carbon Dioxide, the Administration decided to sit this year out.

Research Needs

We are continually discovering that urban and forests are more important than imagined and can play an even greater role in mitigating climate change impacts in our urban areas. The Sustainable Urban Forests Coalition recently noted that "research into the benefits of urban forests and the threats they face is more important than ever before. Research that allows for adaptive science and bridges the gap to implementation is especially needed by public managers, private industry, and individuals alike seeking to expand and protect their urban forest resources and improve quality of life in their communities."[51]

One key starting point is a statewide inventory of urban forest carbon stocks that is regularly updated, which would likely require high resolution remote sensing of urban tree canopy and a relatively dense network of permanent plots. The San Jose Case Study attached in the appendices could help inform this process.

Developing an increased understanding of how climate change will affect urban environments, social systems and tree growth and longevity is also essential. Improved tools for modeling effects of urban forests on urban microclimates, human thermal comfort and building energy use will assist in this endeavor. On the latter point, research that would help further quantify and validate energy savings through urban forestry could be supported through relevant portions of the EPIC Program administered by the California Energy Commission.

Case Study: Biopower and Million Trees LA

Crown Disposal loaded chips from pruned and removed yard trees into heavy duty trucks (6.4 mpg, 2% biodiesel) that hauled the material 305.8 miles to a biopower plant in Dinuba, CA. Approximately 10 percent of return trips involved a backhaul, and 600 round trips hauls were completed annually. The Dinuba plant operated 70 percent time and consumed 80,626 t of biomass to produce 73,584 MWh annually. It consumed on-site 7,211 MWh of electricity and 37,000 gal of diesel fuel by vehicles that handled the biomass. Electricity was sold to Pacific Gas & Electric, whose utility emission factor was 871 lb CO_2

Source: Communication between Dr. Greg McPherson and Mr. Jerry Prieto

Increased understanding of opportunities and practices to reduce GHG emissions associated with tree irrigation, operation of vehicles and tree care equipment, and disposal of removed tree biomass (i.e., utilization as wood products, biopower and fuel) will not only advance opportunities in this sector, but also help further integrate urban forestry in cross-cutting efforts.[52]

Public Policy Recommendations

Over the last decade, the relevance and prevalence of urban forestry as a valued and integral aspect of our urban infrastructure has gained more traction than ever before. This is demonstrated in the integration of urban

[51] Sustainable Urban Forests Coalition Urban Forestry Research Working Group. July, 2013. DRAFT Research and Development Platform.
[52] Ibid.

forestry into health policy and impact reports, working papers on the positive effects of trees in reducing crime, and, of course, an increased awareness of the GHG emission reduction potential of a healthy and expanded urban forest. But there is more to do that can help shape vital public policies to further advance AB 32 implementation, bridge the social equity gap, and meet additional ecosystem needs.

In conclusion, as CARB works towards a 2013 Scoping Plan that will inform what public policies will be developed over the next several years to further advance AB 32 implementation, we encourage the Board to explore and consider the following policy recommendations as they relate to urban forestry:

- Develop policies that promote development of markets for urban forestry-related services that could stimulate investment in urban forest carbon projects by developing new revenue streams related to the ecosystem services provided by them.

- Utilize CARB's Investment Plan to the maximum extent feasible to inform investments within the natural resources sector for reduced GHG emissions and other ecosystem benefits.

- Follow CAR's lead and revise CARB's Compliance Offset Protocol for Urban Forest Projects to provide a more competitive market for urban forestry offset projects.

- Support optimal urban forest and other green infrastructure configurations that maximize desired ecosystem services and integrate with Sustainable Communities Strategies.

- Support science to better understand the health impacts of urban tree cover and other green infrastructure with emphasis on increased information and knowledge of physical, mental, and societal impacts of urban forest ecosystems and the services they provide.

- Develop uniform standards and market infrastructure for monetizing ecosystem services.

- Encourage utilization of uniform assessment tools across all sectors to accurately quantify and verify GHG reductions achieved through specific projects implementation.

- Encourage policies and practices that significantly reduce the disproportionate environmental burdens and impacts on California's disadvantaged communities through increased green infrastructure investments

- Create models and decision tools to support urban forest threat forecasting and management. This would include quantifying and predicting pest invasions, land-use development, and climate change scenarios and their impacts on urban forests and the ecosystem services they provide.

- Improve the usefulness of urban forest research through synthesis, technology development, and delivery. This should include creating a strategic statewide framework to support urban forest resource management, policy development, and stewardship through applied research and technology transfer.

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III. Wetlands

Introduction

Wetlands in California, through conservation, management[53] and restoration, can sequester additional carbon dioxide from the atmosphere and store significant carbon within their soils, helping the state meet its greenhouse gas (GHG) reduction goals. Their protection and management can also avoid emissions of carbon dioxide and other GHG gases from the soil that might otherwise occur due to conversion or particular unsustainable management practices.

In addition to GHG reductions, healthy wetlands provide a host of benefits. These include water purification, ground water and surface flow regulation, wildlife habitat, flood and surge impact reduction, water temperature moderation, erosion control, and stream bank stabilization. They also benefit surrounding communities by providing recreation, enhanced aesthetics, and farming and fishery jobs. For example, California's Sacramento-San Joaquin Delta is critical to the sustainability of the state's water supply which provides irrigation water for 3 million acres of agriculture, drinking water for over 23 million people and provides habitat for over 500 species of wildlife and is critical for the state's water supply.

The following sections provide background on California's wetlands and their potential to help California meet its long term greenhouse gas reduction goals alongside other important benefits. Finally, it provides discreet policy recommendations to achieve these benefits.

Background: Wetlands and Connection to Climate Change

Wetlands in California are both coastal and inland, spanning freshwater and coastal waters. They are defined by the federal Environmental Protection Agency as "areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."[54] California's wetlands include the saline wetlands along the coast, freshwater wetlands, including the Sacramento-San Joaquin Delta and further upland, and the brackish wetlands of the Suisun Marsh.

Approximately 90% of California's original wetland acreage has already been converted to other uses compared to what existed two centuries ago.[55] This loss was largely due to conversion from open space to uses such as agriculture and urbanization. When wetlands are converted to other uses, the climate and myriad other benefits are often degraded or permanently lost. Roughly 2.9 million acres of wetlands still exist across the state with recognition and concerted efforts across the state to restore them.

In California, one of the formerly largest freshwater wetland areas, spanning 738,000 acres, is the Sacramento-San Joaquin Delta. It is currently estimated that, due to ongoing agricultural practices and resulting subsidence and oxidation of the peat soils, the Delta emits roughly 1.5 to 2 million metric tons of carbon dioxide annually approximately equivalent to about annual emissions from 310,000 passenger vehicles. This subsidence and

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[53]This management includes changes in practices and management of water

[54] Environmental Protection Agency

[55] Dahl, Thomas E. 1990. Wetlands losses in the United States 1780's to 1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://npwrc.usgs.gov/resource/wetlands/wetloss/index.htm (Version 16JUL97).

emissions continue in areas of the Central Delta (up to 300,000 acres) that are below sea level, creating additional challenges for agriculture, water supply, levee stability, wildlife habitat, and sea level rise (see figures 1 and 2 from Mount and Twiss).[56] It is estimated that about 1.9 million acre feet are below sea level in the Delta[57]. Subsidence since the late 1800s has resulted in the loss of about 3 billion cubic yards of organic soils.[58]

Figure 1

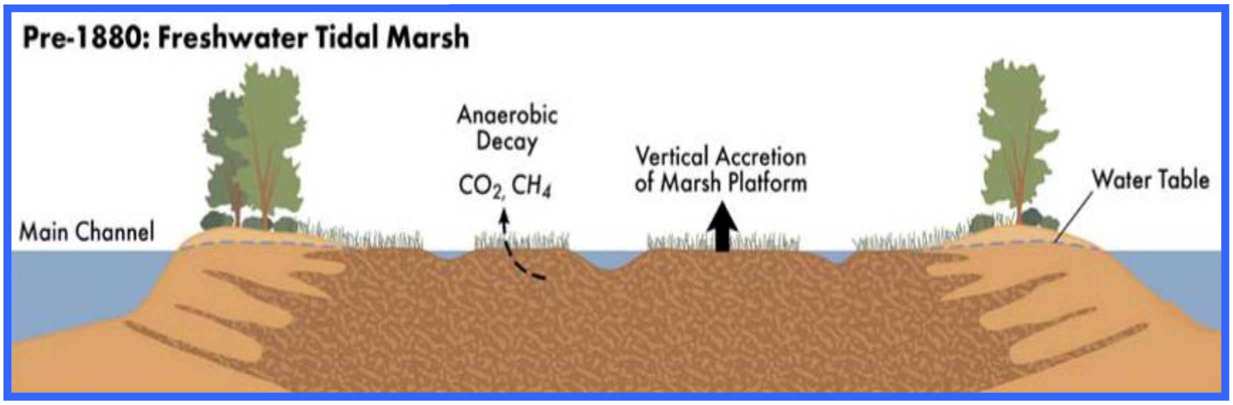
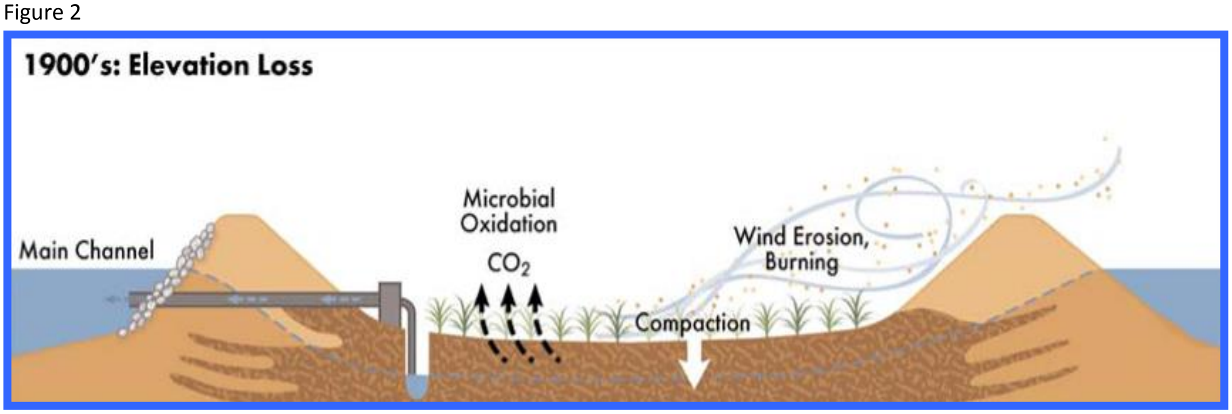


Figure 2



While emissions from the Delta pose a climate risk, it is also an opportunity to address climate change. Through changes in management practices and restoration (e.g., planting tules[59]) in the most deeply subsided areas of the Delta, it is possible to change these areas from being a source of GHG emissions to a net "sink" or carbon reservoir. Current emissions could be reduced and the planting and management for tules could lead to the net sequestration of carbon dioxide, with a total benefit of about 14 metric tons of CO2e per acre in the Delta annually.[60] In addition, these actions could also help reverse the effects of subsidence of the peat soils, helping to offset the effects of sea level rise and protect water quality and supply, agricultural jobs and wildlife.

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[56] Mount J, Twiss R. 2005. Subsidence, sea level rise, seismicity in the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed Science. Vol. 3, Issue 1 (March 2005), Article 5. http://repositories.cdlib.org/jmie/sfews/vol3/iss1/art5

[57] Deverel, Steven J, & Leighton, David A. (2010). Historic, Recent, and Future Subsidence, Sacramento-San Joaquin Delta, California, USA. San Francisco Estuary and Watershed Science, 8(2).: http://www.escholarship.org/uc/item/7xd4x0xw

[58] ibid and Mount and Twiss (footnote 3)

[59] Tule is a giant species of sedge that is native to freshwater marshes and is native to California

[60] Miller, R.L., Fram, M.S., Wheeler, G., Fujii, R., 2008. Subsidence reversal in a re-established wetland in the Sacramento-San Joaquin Delta, California, USA. San Francisco Estuary and Watershed Science, 6(3): 1-24.

Initial studies also indicate that wetlands and restoration along California's coastal areas like the San Francisco Bay could produce significant climate benefits. An analysis of eight wetland sites around the San Francisco Bay indicated that natural tidal wetlands were providing carbon sequestration benefits annually and that restored sites would likely provide similar benefits.[61] Site-specific estimates of carbon sequestration rates ranged from 41.7 to 232 .4 grams per square meter (or .17 - .94 metric tons) annually.[62] While additional research should be conducted to estimate the full potential of greenhouse gas emission reductions associated with coastal wetland restoration, as well as any potential emissions, these results are promising and offer the state an opportunity to include coastal wetlands in its climate policies and plans.

With the potential for the Delta and other wetlands across the state to contribute to state efforts to reduce GHG emissions and address climate change, we offer the following recommendations for the Scoping Plan update:

Policy recommendations to facilitate GHG reductions in California wetlands and additional co-benefits

- Conservation easement and fee acquisitions
    - Provide additional funds to promote easement and fee acquisitions that avoid wetland conversion and promote management practices that reduce emissions and sequester additional carbon (e.g., tule restoration, alternative crops such as rice which has been demonstrated to reduce carbon emissions relative to the status quo[63], infrastructural upgrades)
    - Additional funds will be needed to fund state conservancies such as the Delta and Coastal Conservancies to fund easements and fee acquisitions
    - Funds could be provided through cap and trade auction proceeds and future bond measures

- CEQA GHG mitigation
    - Expand CEQA guidelines to address GHG emissions resulting from wetland conversion and require mitigation
- Capacity building
    - Build capacity of state and regional agencies and local non-profits (watershed groups) to restore, monitor and assess wetland health and restoration for carbon and other benefits
    - Conduct outreach (through UC extension and state conservancies) to private landowners to educate on management practices that help address climate change
    - Implement demonstration projects in the Delta and in other wetlands to demonstrate actions that will reduce GHG emissions and sequester carbon; such pilots will build capacity but also help gain input and support from landowners to design and adopt practices that are beneficial for the climate

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Miller, Robin L., 2011 Carbon Gas Fluxes in Re-Established Wetlands on Organic Soils Differ Relative to Plant Community and Hydrology, Wetlands DOI 10.1007/s13157-011-0215-2

[61] Callaway, John C. et al. Carbon Sequestration and Sediment Accretion in San Francisco Bay Tidal Wetlands. Estuaries and Coasts, September 2012, Volume 35, Issue 5, pp 1163-1181: http://link.springer.com/content/pdf/10.1007%2Fs12237-012-9508-9.pdf

[62] Id.

[63] Jaclyn A. Hatala*, Matteo Detto, Oliver Sonnentag, Steven J. Deverel, Joseph Verfaillie, Dennis D. Baldocchi, 2012, Greenhouse gas (CO2, CH4, H2O) fluxes from drained and flooded agricultural peatlands in the Sacramento-San Joaquin Delta, Agriculture, Ecosystems and Environment , 150,1-18.

    - Develop GHG protocols for landowner scale activities that will reduce emissions and sequester carbon for carbon market or other financial incentives
- Develop market-based incentives for wetland conservation and GHG reductions
    - Develop and adopt GHG reduction protocols for wetlands conservation and changes in management and include in cap and trade program
- Delta specific recommendations
    - Develop a Delta Conservancy GHG incentives program
        - Provide auction proceeds to Delta Conservancy to develop farm scale demonstration projects to reduce GHG emissions and incentive program to reduce emissions through changes in management
    - Assess and monitor GHG reductions to be achieved by Bay Delta Conservation Plan (if implemented)
    - Through easement acquisition, minimize development/conversion in the secondary zone (e.g., Elk Grove, West Sacramento, Stockton) of the Delta to avoid emissions
- Research, mapping and monitoring
    - Define best management practices for managed wetlands for maximizing carbon accretion and minimizing collateral effects such as mosquito breeding.
    - Complete statewide wetland mapping and monitoring and incorporate carbon emissions/sequestration and other climate impacts
    - Conduct additional analysis on coastal wetlands to estimate total net carbon sequestration potential through restoration and avoided conversion efforts, with a focus on San Francisco Bay
    - Conduct additional analysis on potential methane emissions associated with wetland restoration and how to minimize such emissions where they may occur
- Incorporate Delta and other wetlands in statewide GHG inventory
    - The state should establish a GHG baseline for the Delta, Suisun Marsh and other areas to monitor progress and impacts over time
- Barriers/hurdles to overcome
    - Lack of funding and capacity at state, regional and local levels
    - Cultural/educational
    - Coordination among federal, state and local stakeholders

Conclusion:

Like other California landscapes, wetlands provide an opportunity for the state to effectively and holistically address climate change as part of a suite of strategies. They offer the opportunity to minimize emissions and to sequester additional carbon from the atmosphere through actions like changes in management, restoration and avoided conversion. At the same time, they offer the unique opportunity to address climate change impacts such as flood and sea level rise. Their conservation will have numerous public benefits beyond climate, including the protection of water supply and quality for Californians, agricultural jobs, and critical habitat for fish and wildlife.

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V. Grasslands/Rangelands

California is home to unique and vast rangelands that provide multiple environmental and economic benefits to the state, including climate protection. California's rangelands cover 63 million acres, of which 34 million acres are actively grazed with cattle and other livestock.[64] These grasslands are made up of annual and perennial grasses, native and introduced plant species. Their per acre carbon stocks are low compared to mature forests, but taken in total California rangelands provide substantial carbon sinks, accounting for 28 percent of California's stored carbon.[65]

Atmospheric carbon is stored in the soils and woody biomass of rangelands through photosynthesis. Globally, grasslands store one-third of the world's soil carbon.[66] California rangelands have a wide range in soil carbon pool size and high soil carbon storage capacity.[67]

A 2010 study in Yolo County compared the soil carbon stocks of cropland and rangeland. While all types of agricultural land provided carbon storage (see Figure 1), rangelands with riparian zones stored nearly two times more carbon per acre relative to the neighboring grazed field.[68] In both the cropland and rangeland acres, those with woody biomass (trees, shrubs) in their riparian zones stored more carbon than those acres with fewer trees and shrubs.

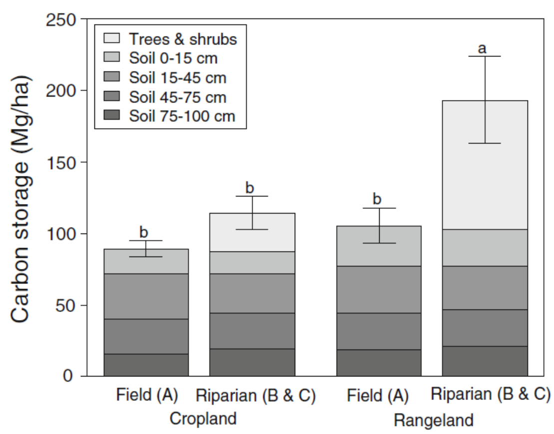

Figure 1. Carbon storage in soil and woody vegetation for fields and riparian zones as found in both cropland and rangeland use types. This study was based on 20 riparian sites with adjacent fields all located in Yolo County.[69]

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[64] California Rangelands. Plant Sciences. UC Davis.
http://californiarangeland.ucdavis.edu/California%20Vegetation/Vegmaps/Califacres.html

[65] Eviner, V. UC Davis. 2013. Presentation at CalCAN Summit.
http://dl.dropboxusercontent.com/u/47968538/Valerie%20Eviner.pdf

[66] Silver, W. April 2013. Workshop presentation.
http://nicholasinstitute.duke.edu/sites/default/files/w_silver_et_al_april_3013_carb.pdf

[67] Ibid.

[68] Young-Mathews, A., S. Culman, et al. (2010). "Plant-soil biodiversity relationships and nutrient retention in agricultural riparian zones of the Sacramento Valley, California." Agroforestry Systems 80(1):41–60.
http://agadapt.ucdavis.edu/farmscaping/

[69] Ibid.

Current research suggests that changes in rangeland management may increase carbon sequestration. Limiting overgrazing, which can lead to soil erosion and riparian damage, will increase soil carbon stocks in rangelands.[70] Additional management practices, including adding organic soil amendments such as compost[71] may also increase carbon sequestration potential in rangelands.

Limiting the conversion of rangelands to urban/peri-urban development can also prevent significant loss of carbon storage and avoid transportation-related emissions associated with development. A 2012 Yolo County study found that urban land uses emit 70 times more emissions per unit area than irrigated cropland and even more compared to an acre of rangeland (Table 1).[72]

	Land Area		Average Emissions Rate	
Land-use Category	1990	2008	1990	2008
	----- acres -----		--- MT CO_2e $acre^{-1}$ yr^{-1} ---	
Rangeland	131,945	135,717	0.28	0.32
Irrigated Cropland	344,335	324,654	0.87	0.80
Urbanized Land*	22,471	29,881	61.50	--

Table 1. Land area and average emissions rates (MT CO2e acre-1 yr-1) for rangeland and irrigated cropland and urbanized land in Yolo County during 1990 and 2008.

Achieving Multiple Benefits on Rangelands

The protection of California rangelands offers benefits in addition to climate mitigation. Rangelands offer wildlife habitat and corridors to facilitate species migration and movement — particularly important as wildlife is forced to adapt to a changing climate. Well-managed rangelands serve to collect and filter water and act as groundwater reservoirs within watersheds, characteristics that are enhanced when the soil organic matter is increased with practices that also sequester carbon. Livestock production on our rangelands is a significant economic contributor to our agricultural economy. Rangelands also provide social benefits such as open space and recreational opportunities and they are an important part of California's unique agricultural heritage.

Cuts to Land Protection Programs Hurts Conservation, Climate Change Mitigation

California has relied on bond-funded conservation easement programs (e.g. California Farmland Conservancy Program and the Rangeland, Grazing Land and Grassland Protection Program) and the Williamson Act state subvention program to protect agricultural lands, including rangelands, from development. Unfortunately, with declining bond funding and the elimination of state funding for Williamson Act subvention payments, the state has few resources to support agricultural land conservation. For many ranchers on private rangelands the reduction in property taxes they receive by enrolling in the Williamson Act represents the difference between being profitable or not.[73] Without adequate resources to support conservation, California will continue to lose

[70] Based on interviews with several rangeland ecologists for forthcoming report by CalCAN.
[71] Silver. Ibid.
[72] Jackson, L.E., F. Santos-Martin, A.D. Hollander, W.R. Horwath, R.E. Howitt, J.B. Kramer, A.T. O'Geen, B.S. Orlove, J.W. Six, S.K. Sokolow, D.A. Sumner, T.P. Tomich, and S.M. Wheeler. 2009. Potential for adaptation to climate change in an agricultural landscape in the Central Valley of California. California Energy Commission, PIER. CEC-500-2009- 044-F. http://www.energy.ca.gov/2009publications/CEC-500-2009-044/CEC-500-2009-044-F.PDF
[73] Wetzel, William C., Lacher L.L., Swezey, D.S., Moffitt , S.E., Manning D.T. Analysis reveals potential rangeland impacts if Williamson Act eliminated. OCT,–DEC. 2012. California Agriculture.

agricultural land at its currently alarming rate of 30,000 to 50,000 acres per year.[74] With the loss of agricultural land, we also lose important carbon sinks.

Research Needs: Rangeland Management
More research is needed on the effect of various management practices and regional variations on the carbon sinks of rangelands. As mentioned above, altered grazing management (rotational grazing, change in stock rates), plantings of woody species, perennial grasses and legumes along with organic amendments all offer promise for increasing carbon sequestration in California's rangelands. Investments in research will inform efforts to improve the state's carbon sinks.

Recommendations
The Scoping Plan Update can provide strategies to improve rangeland conservation in the state and the use of management practices that provide climate benefits, including:

- Grants to land trusts and local government for voluntary conservation easements on rangeland prioritizing land threatened by urban and suburban sprawl
- Funding of the Williamson Act state subvention program and revision of the program to account for GHG reductions and prioritize rangeland conservation on the urban/suburban edge to provide climate benefits
- Smart growth planning grants for local government that prioritize rangeland protection in partnership with local farmers and ranchers
- Guidance from the state to local government on working lands mitigation requirements under CEQA and general plan guidelines
- Research funding on the effect of rangeland management practices and regional variations on the carbon sinks of rangelands
- Technical assistance for ranchers and landowners on management strategies to increase carbon sequestration while providing multiple benefits, including improved water quality, wildlife habitat and improved profitability

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Conclusion

The AB 32 Scoping Plan update provides an important opportunity for the state to bring together its efforts to tackle climate change while furthering a California that supports job creation, healthy communities and a thriving

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http://rangelandwatersheds.ucdavis.edu/publication%20list%20and%20files/CalAG_WillaimsonAct_Wetzel_et_al_2012.pdf

[74]For more on farmland loss and conservation issues, see http://calclimateag.org/triple-harvest/
For more on working lands conversion from the Dept. of Conservation see:
http://www.conservation.ca.gov/dlrp/fmmp/pubs/2006-2008/Pages/FMMP_2006-2008_FCR.aspx

environment. Since 2008, advances in science have deepened our collective understanding of the impacts of a changing climate. We cannot rely on any one sector or a handful of strategies to reduce our greenhouse gas emissions and improve our resilience. Multiple strategies from all sectors are needed if we are to be successful. Natural and working lands are central to these efforts given their significant footprint in the state and their ability to provide a host of co-benefits, in addition to their fundamental role in carbon sequestration.

Finally, the Scoping Plan update must work in concert with the Cap-and-Trade Auction Proceeds Investment Plan so that we are strategically investing in the activities outlined in the update. As we look to investments in the coming years from the auction proceeds, the Scoping Plan update, in tandem with the Investment plan, will provide a roadmap for how California will lead in the creation of a robust green economy. We look forward to working with CARB and the Administration, other state agencies and the legislature to ensure this success.