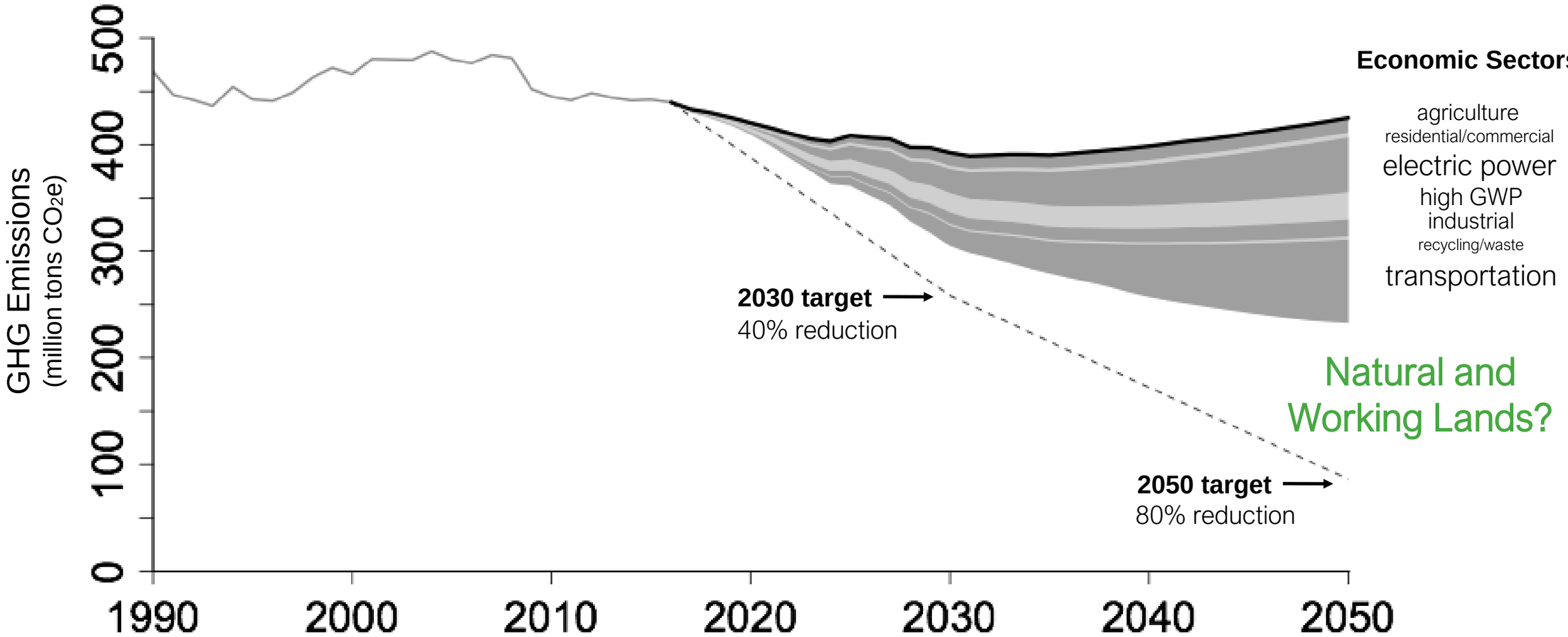
Ecosystem-based emissions reduction potential in California

Dick Cameron, Director of Science for Land Programs,
California Chapter

The Nature Conservancy

California's emissions future?



Source: 2030 Scoping plan

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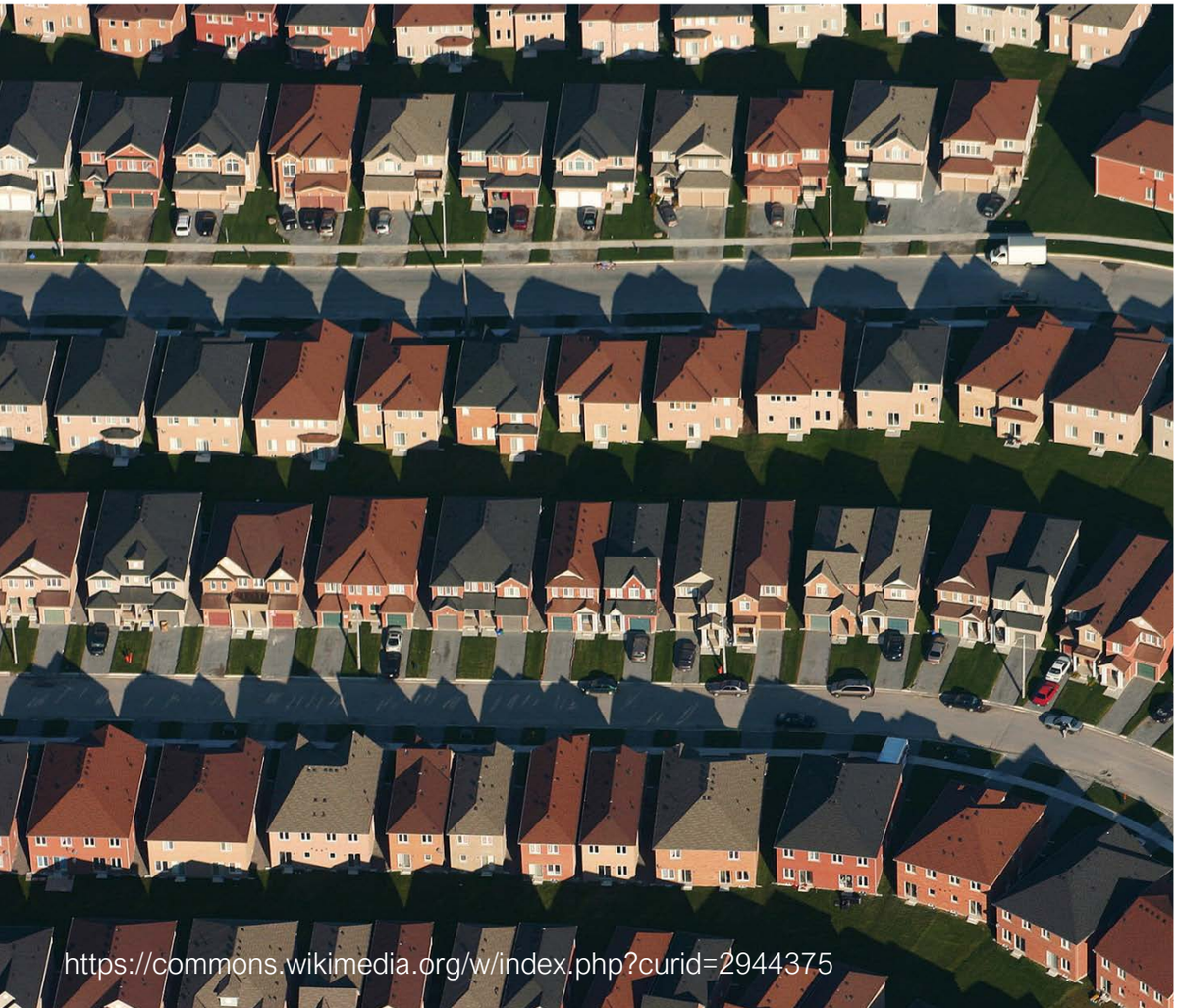
Scott Warren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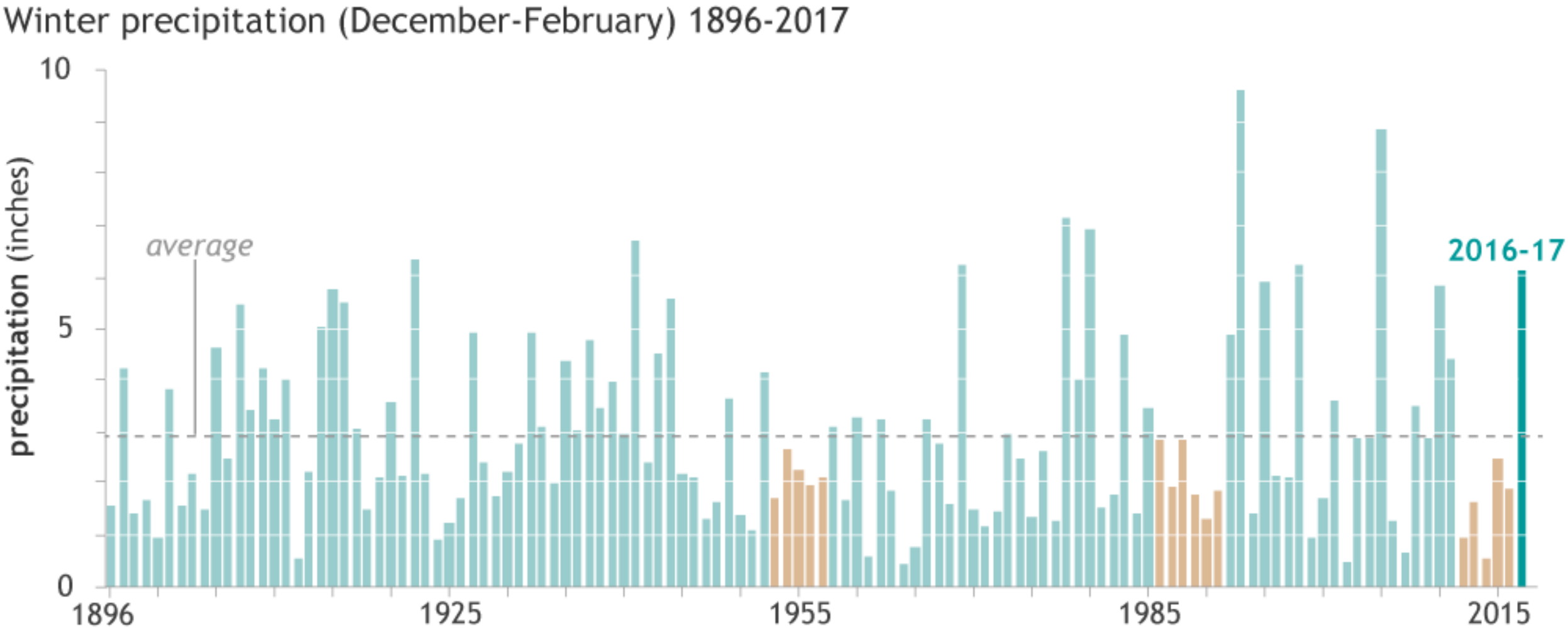
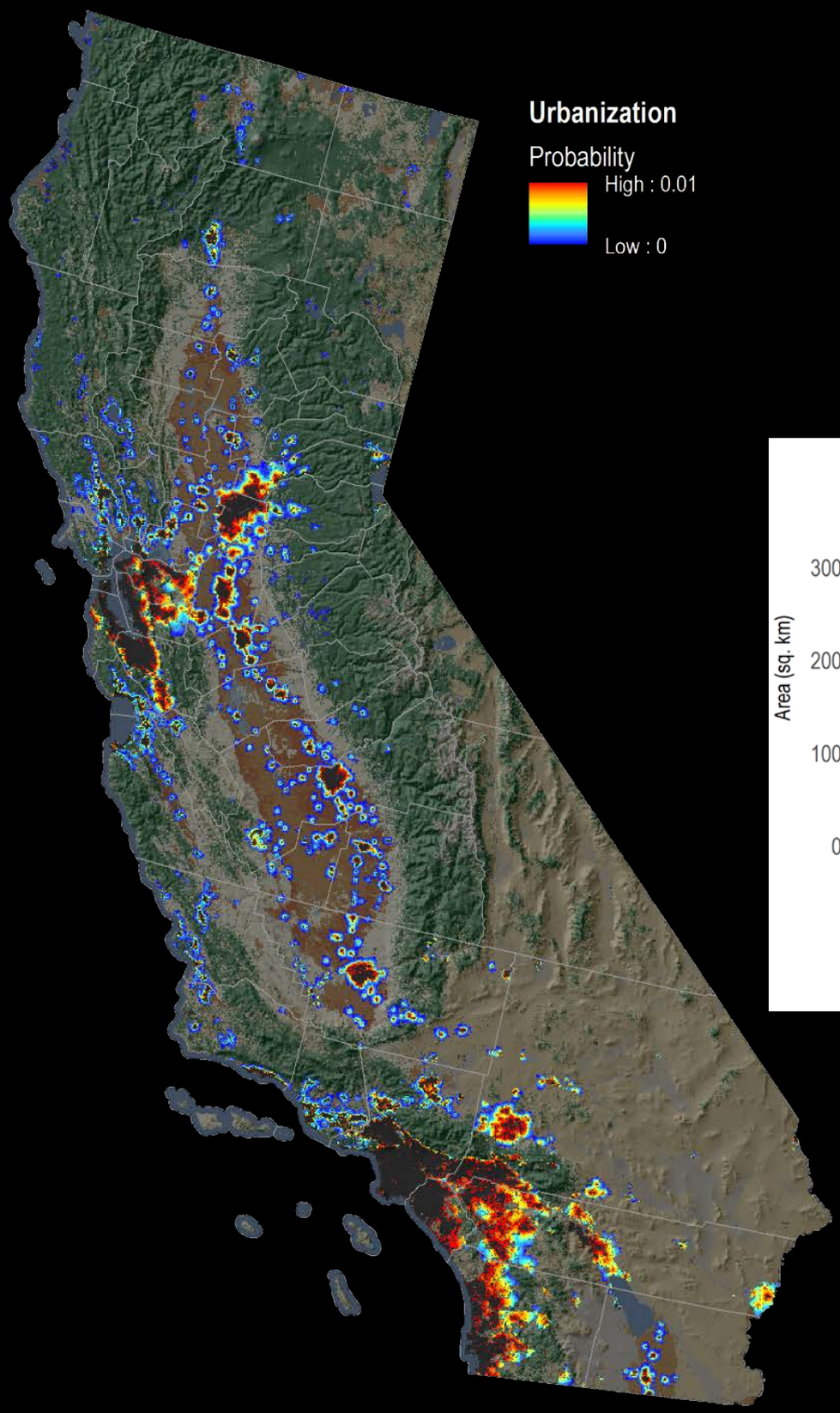
Andrew Peacock

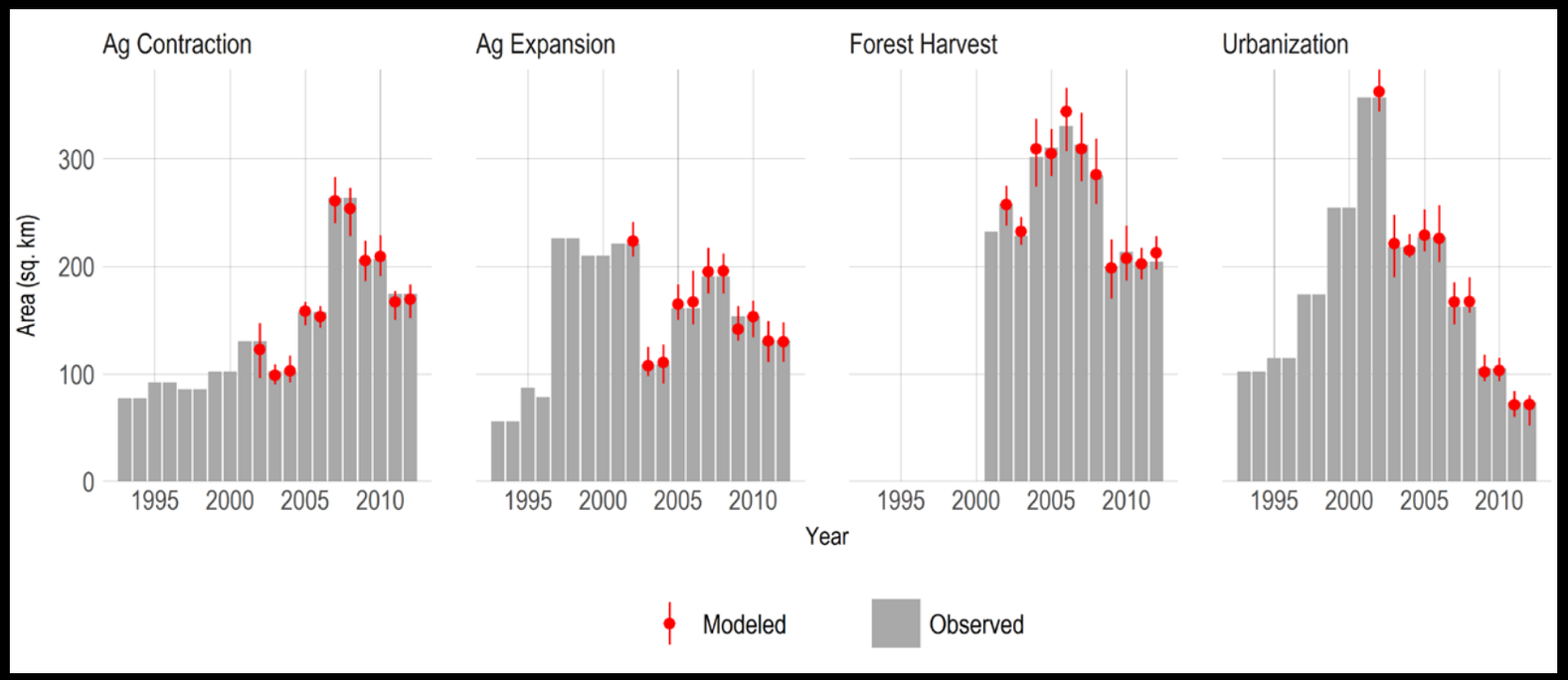


www.climate.gov

https://www.climate.gov/sites/default/files/CA_climdiv7_winterprecip1896-2017_lrg.png



Land use drivers variable in space and time



Sleeter et al.. 2017. Future scenarios of land change based on empirical data and demographic trends, *Earth's Future*

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Ecosystem management and land conservation can substantially contribute to California's climate mitigation goals

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Modeling efforts focused on future greenhouse gas (GHG) emissions from energy and other sectors in California have shown varying capacities to meet the emissions reduction targets established by the state. These efforts have not included potential reductions from changes in ecosystem management, restoration, and conservation. We examine the scale of contributions from selected activities in natural and agricultural lands and assess the degree to which these actions could help the state achieve its 2030 and 2050 climate mitigation goals under alternative implementation scenarios. By 2030, an Ambitious implementation scenario could contribute as much as 147 MMTCO$_2$e or 17.4% of the cumulative reductions needed to meet the state's 2030 goal, greater than the individual projected contributions of four other economic sectors, including those from the industrial and agricultural sectors. On an annual basis, the Ambitious scenario could result in reductions as high as 17.9 MMTCO$_2$e·y^{-1} or 13.4% of the state's 2030 reduction goal. Most reductions come from changes in forest management (61% of 2050 projected cumulative reductions under the Ambitious scenario), followed by reforestation (14%), avoided conversion (11%), compost amendments to grasslands (9%), and wetland and grassland restoration (5%). Implementation of a range of land-based emissions reduction activities can materially contribute to one of the most ambitious mitigation targets globally. This study provides a flexible, dynamic framework for estimating the reductions achievable through land conservation, ecological restoration, and changes in management regimes.

land use change | avoided conversion | carbon sequestration | natural lands | agriculture

Over the past two decades, climate science and policy have increasingly recognized the role that forests and other terrestrial ecosystems could play in climate change mitigation. About 30% of global anthropogenic carbon dioxide emissions are absorbed through carbon sequestration from plant growth and associated ecological processes (1). However, clearing and degradation of ecosystems, particularly forests, represents an emissions source roughly equivalent to 9% of total emissions, or about half of the carbon dioxide released globally from the combustion of natural gas (1). Land conservation and changes in ecosystem management can reduce emissions that might otherwise occur from conversion to more intensive uses, land degradation, or natural disturbance, such as fire. In many cases, they can also promote increased sequestration (2, 3). Such interventions may enhance the resilience and adaptive capacity of species and ecosystems and serve to maintain the provision of ecosystem services in the face of accelerating environmental change (4–6).

Globally, many government jurisdictions have committed to reducing emissions [including the sequestration of more greenhouse gases (GHGs)] across natural and agricultural lands as part of their climate change targets under the Paris Agreement. As of 2016, 83% of Intended Nationally Determined Contributions submitted to the United Nations Framework Convention on Climate Change reference land use, land use change, and forestry as key parts of their mitigation contributions (7). However, there is little consistent analysis of the mitigation potential across multiple land-based activities to help governments prioritize investments to reduce net emissions [though see Griscom et al. (8)], particularly at a subnational level where activities and funding can be more specifically directed and aligned.

Subnational jurisdiction commitments have become more common over the last decade as efforts to achieve binding multinational GHG goals languished. California is one such subnational jurisdiction that has been a leader in climate change policy through its early adoption of ambitious GHG reduction goals, as defined in the Global Warming Solutions Act of 2006, commonly known as Assembly Bill (AB) 32. More recently, California has adopted more aggressive GHG reduction goals for 2030 and maintains commitments to reduce emissions even further by 2050. Policies and investments to reduce emissions in the energy and transportation sectors have the state on track to meet its 2020 goal (emissions equal to the 1990 level), but earlier studies have shown that additional reductions are needed beyond existing policies to meet the 2030 and 2050 targets (9, 10). California has recognized the need to reduce emissions through the management and conservation of its "natural and working lands" (i.e., open space, wetlands, urban forests, agricultural lands, and forest lands) (11). To effectively include this sector to help meet the state's long-term climate goals, an assessment of the GHG reduction potential of the state's natural and agricultural lands is needed.

Significance

Combatting climate change will require using all available tools, especially those that contribute to other societal and economic goals, such as natural resource protection and energy security. Conserving and managing natural and agricultural lands to retain and absorb greenhouse gasses (GHGs) are tools that have not been widely integrated into climate policy. Our analysis provides a quantification of potential climate benefits from multiple land-based activities for a jurisdiction with an emissions reduction target (up to 13.3% of the cumulative reductions needed to meet the 2050 target, or nearly three-fourths of a billion metric tons of GHGs). This approach provides a model that other jurisdictions can use to evaluate emissions reductions that might be achieved from conserving and restoring natural lands.

Author contributions: D.R.C., D.C.M., J.M.R., and M.C.P. designed research; D.R.C., D.C.M., and J.M.R. performed research; D.R.C., D.C.M., and J.M.R. analyzed data; and D.R.C., D.C.M., J.M.R., and M.C.P. wrote the paper.

The authors declare no conflict of interest.

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Data deposition: All data and simulation source code are available for download through the Open Science Framework repository (https://osf.io/uhucn).

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This article contains supporting information online at www.pnas.org/lookup/suppl/doi:10.1073/pnas.1707811114/-/DCSupplemental.

- Published November 2017 – Open Access
- 14 activities under 3 policy scenarios, focused on natural ecosystems
- 2030 and 2050 cumulative and annual
- Sectoral comparison

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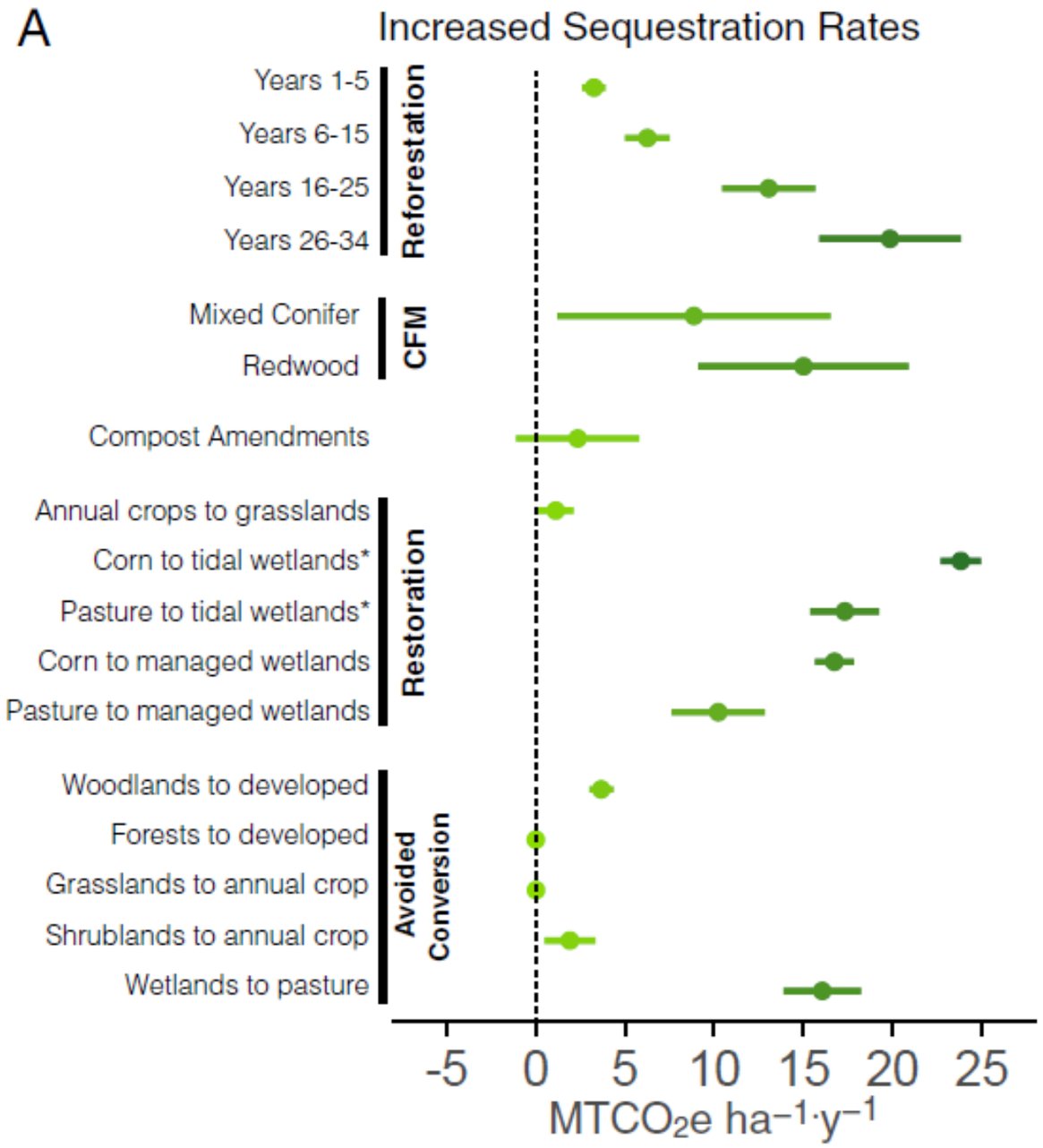

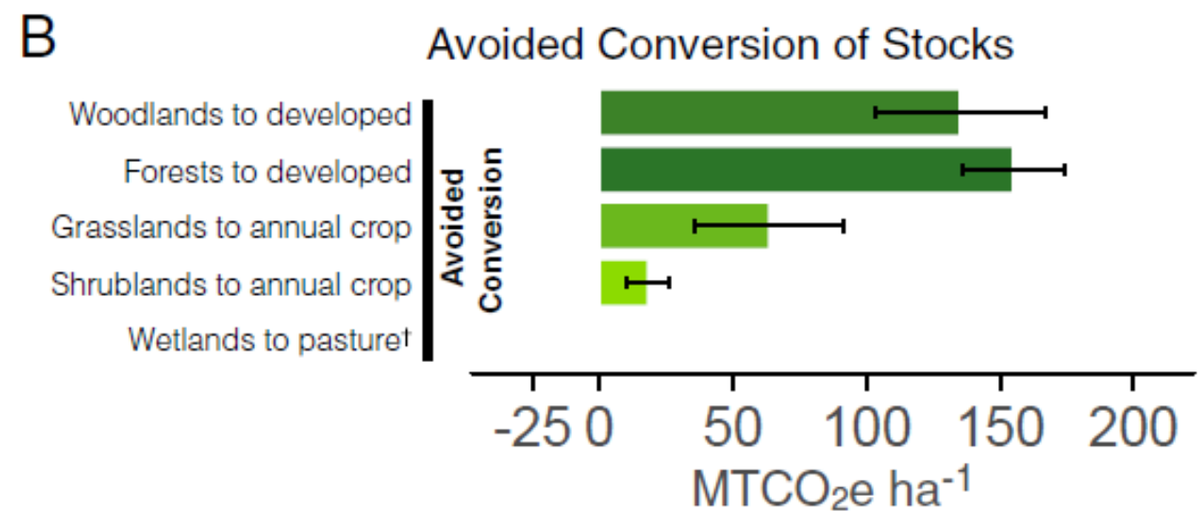

Total Annual Implementation area (ac)

Limited: ~120,000

Moderate: ~215,000

Ambitious: ~300,000

Cameron et al. 2017 PNAS

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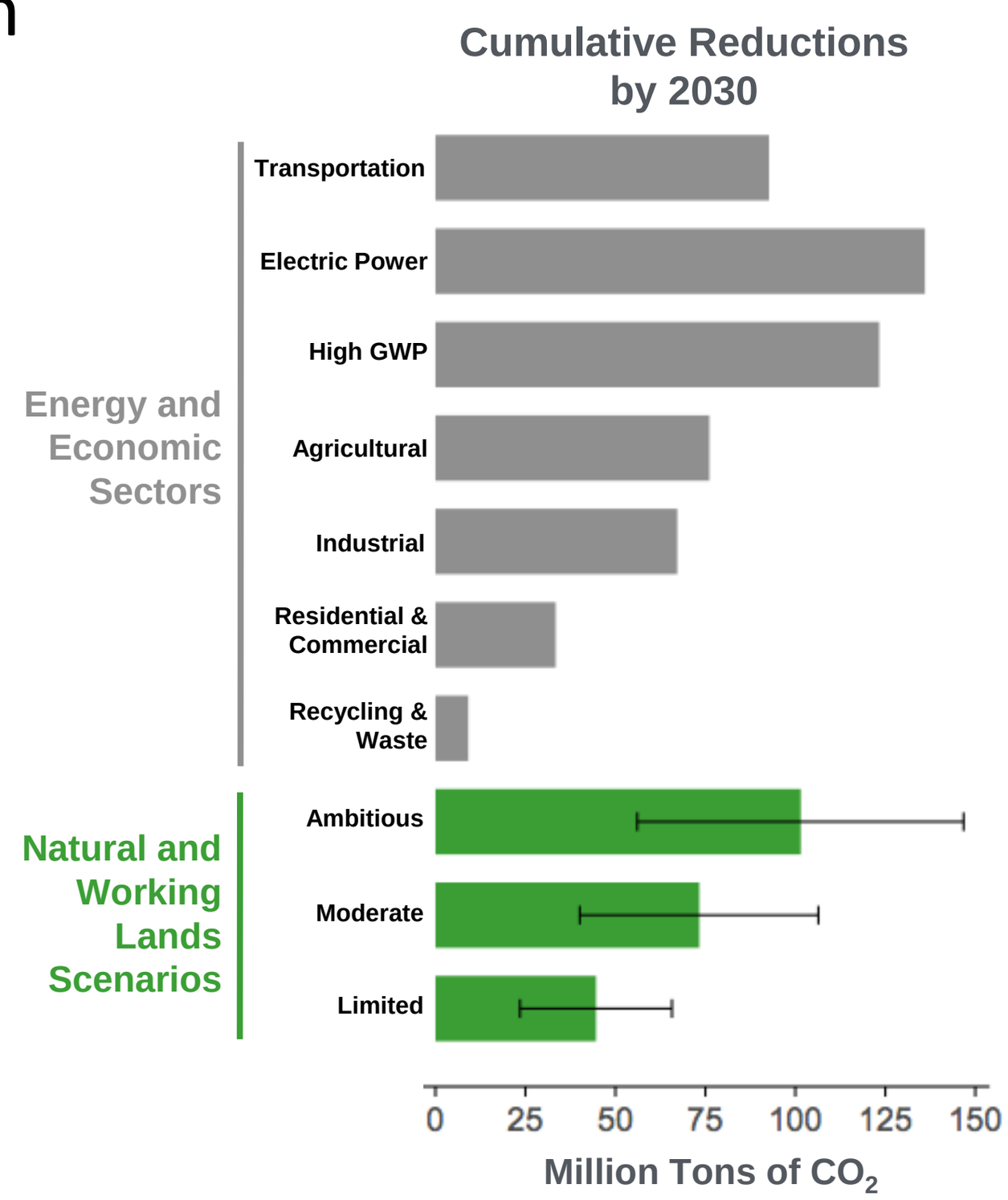
Sectoral comparison

Max of **17.4% of cumulative reductions to meet the 2030 goal**



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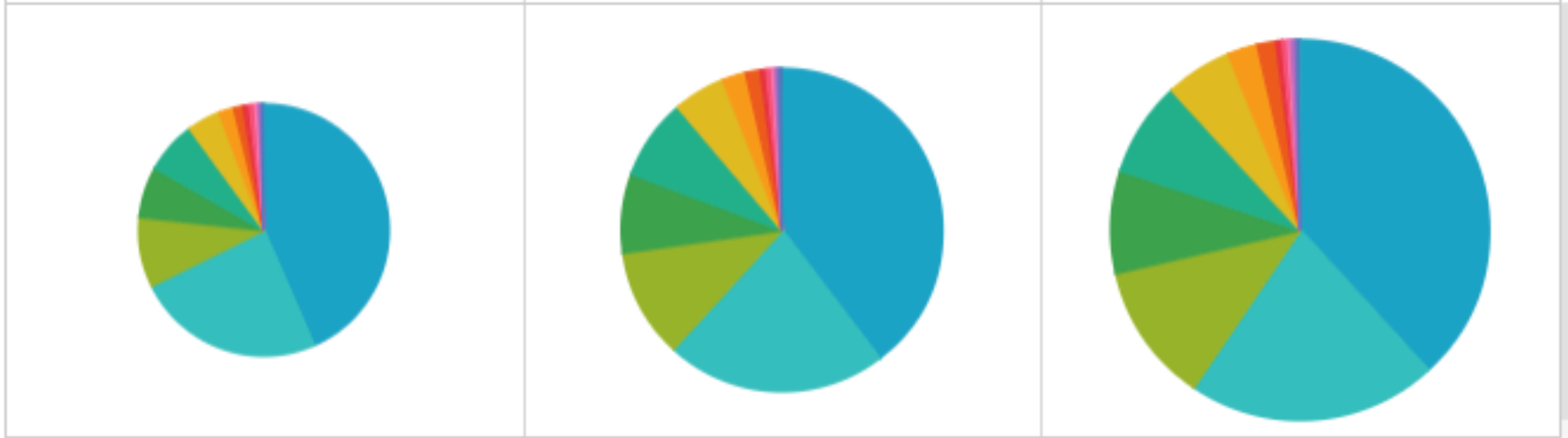
What is the contribution of each activity to the overall reduction potential of California's land base...?

We analyzed 14 different activities that fell into two main catetories: **avoided conversion** (preventing the conversion of a natural area) and **increased sequestration** (enhancing the potential of ecosystems to absorb CO2 from the atmosphere). Perhaps unsurprisingly, those activities involving forests and woodlands make up most of the reduction potential.

Cumulative Reductions by Land-Based Activity

Limited	Moderate	Ambitious
44.6 MMTCO2e	73.2 MMTCO2e	101.5 MMTCO2e



Activity
- Changes to redwood management
- Changes to mixed conifer management
- AC: Woodlands to developed
- Compost amendments to grasslands
- Reforestation
- AC: Forests to developed
- Corn to tidal wetlands
- AC: Grasslands to annual crop
- Corn to managed wetlands
- Pasture to tidal wetlands
- AC: Wetlands to Pasture
- Annual crops to grasslands
- Pasture to managed wetlands
- AC: Shrublands to annual crop

Customize the activities

Use the check boxes to choose which land-based activities to include and use the slider bar to choose the timeline for the reductions. Figures will update based on your selection.

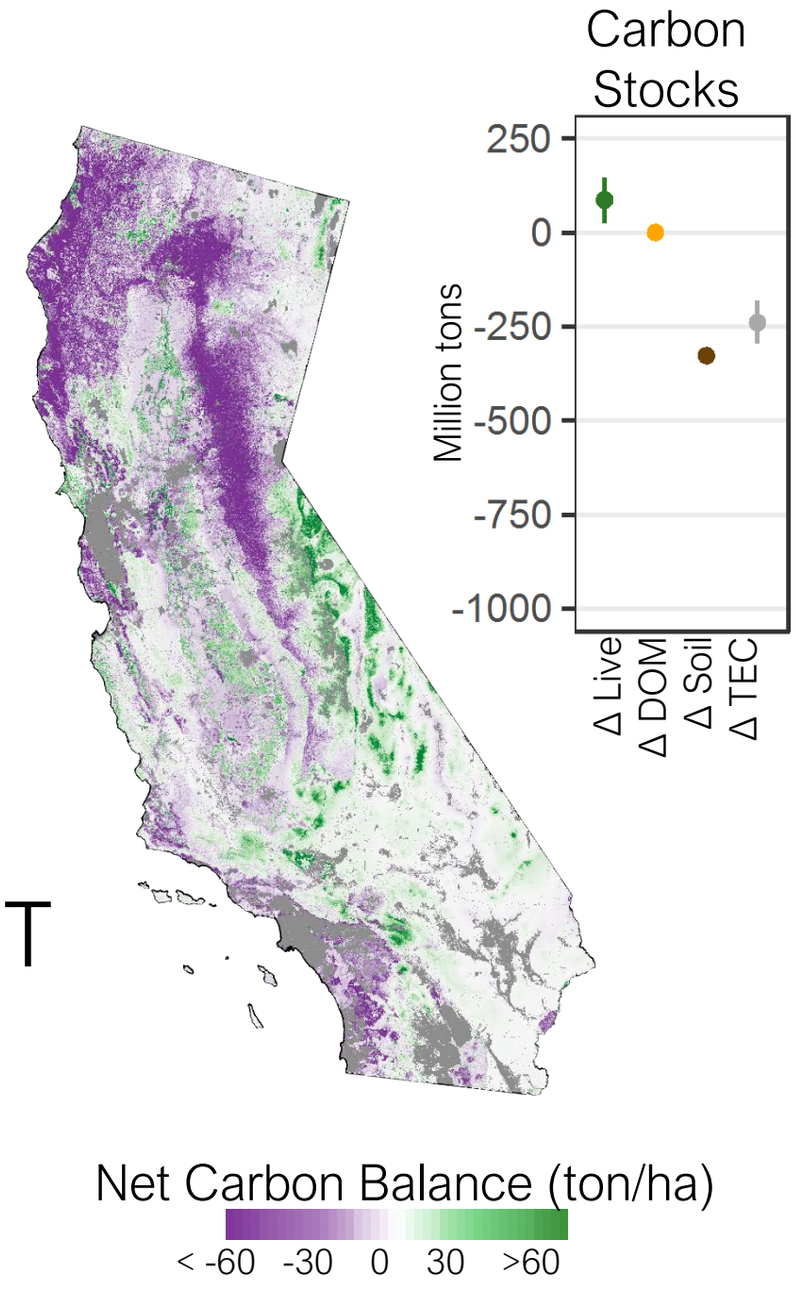
Activity
- [x] (All)
- [x] AC: Forests to developed
- [x] AC: Grasslands to annual crop
- [x] AC: Shrublands to annual crop
- [x] AC: Wetlands to Pasture
- [x] AC: Woodlands to developed
- [x] Annual crops to grasslands
- [x] Changes to mixed conifer ma...
- [x] Changes to redwood manage...
- [x] Compost amendments to gra...
- [x] Corn to managed wetlands
- [x] Corn to tidal wetlands
- [x] Pasture to managed wetlands
- [x] Pasture to tidal wetlands
- [x] Reforestation

Cancel Apply

https://tabsoft.co/2IuEwd0

What are the long term trends given climate and land use scenarios?

- 32 futures, 2001-2100 (4 land use scenarios, 4 climate models, 2 emissions trajectories)
- Climate-driven wildfire (Westerling)
- Timber harvest and drought-induced tree mortality incorporated
- 1-km spatial resolution



"Average" (CanESM) climate future, high land use, RCP8.5

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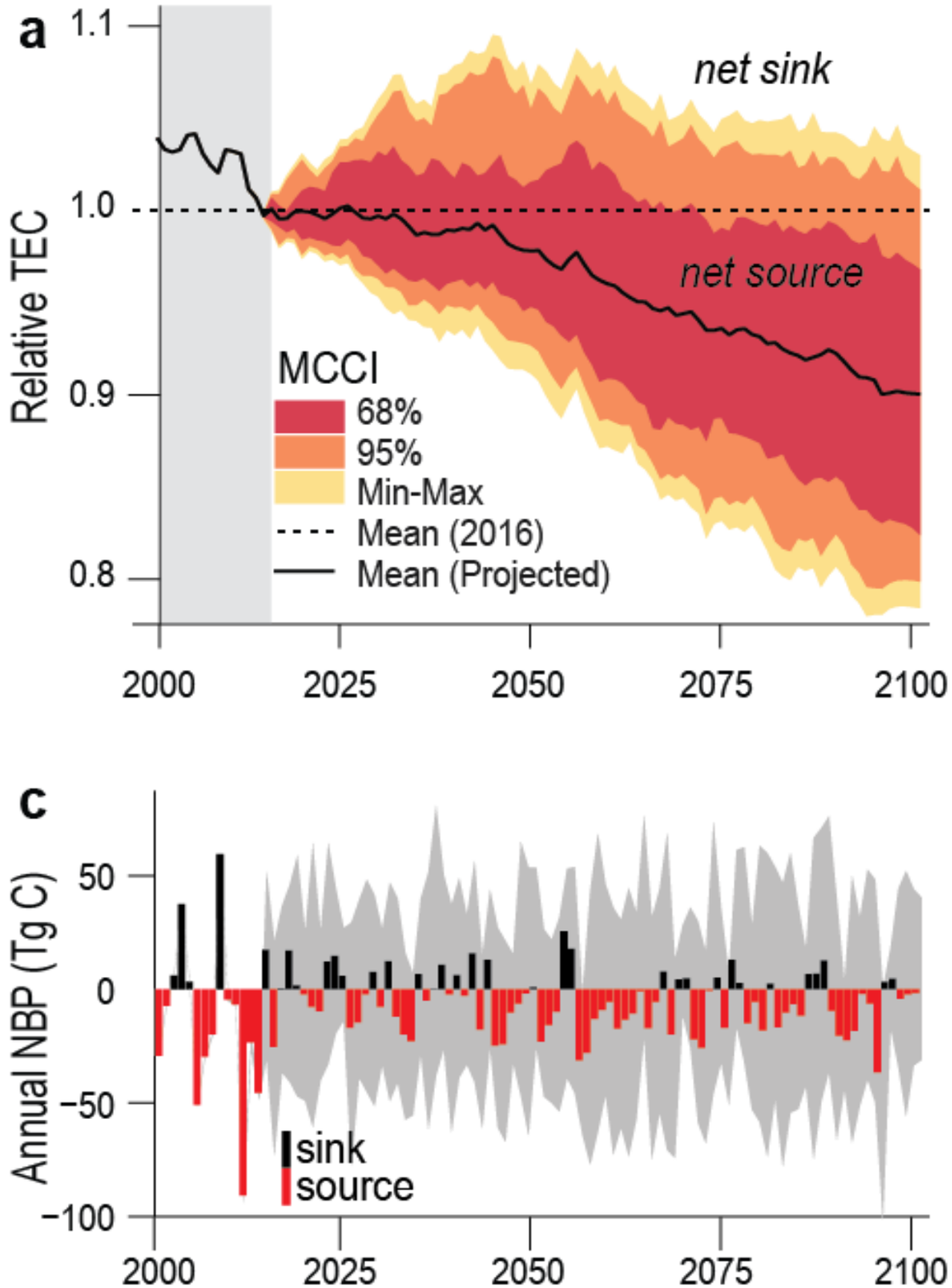
Carbon dynamics of California's lands



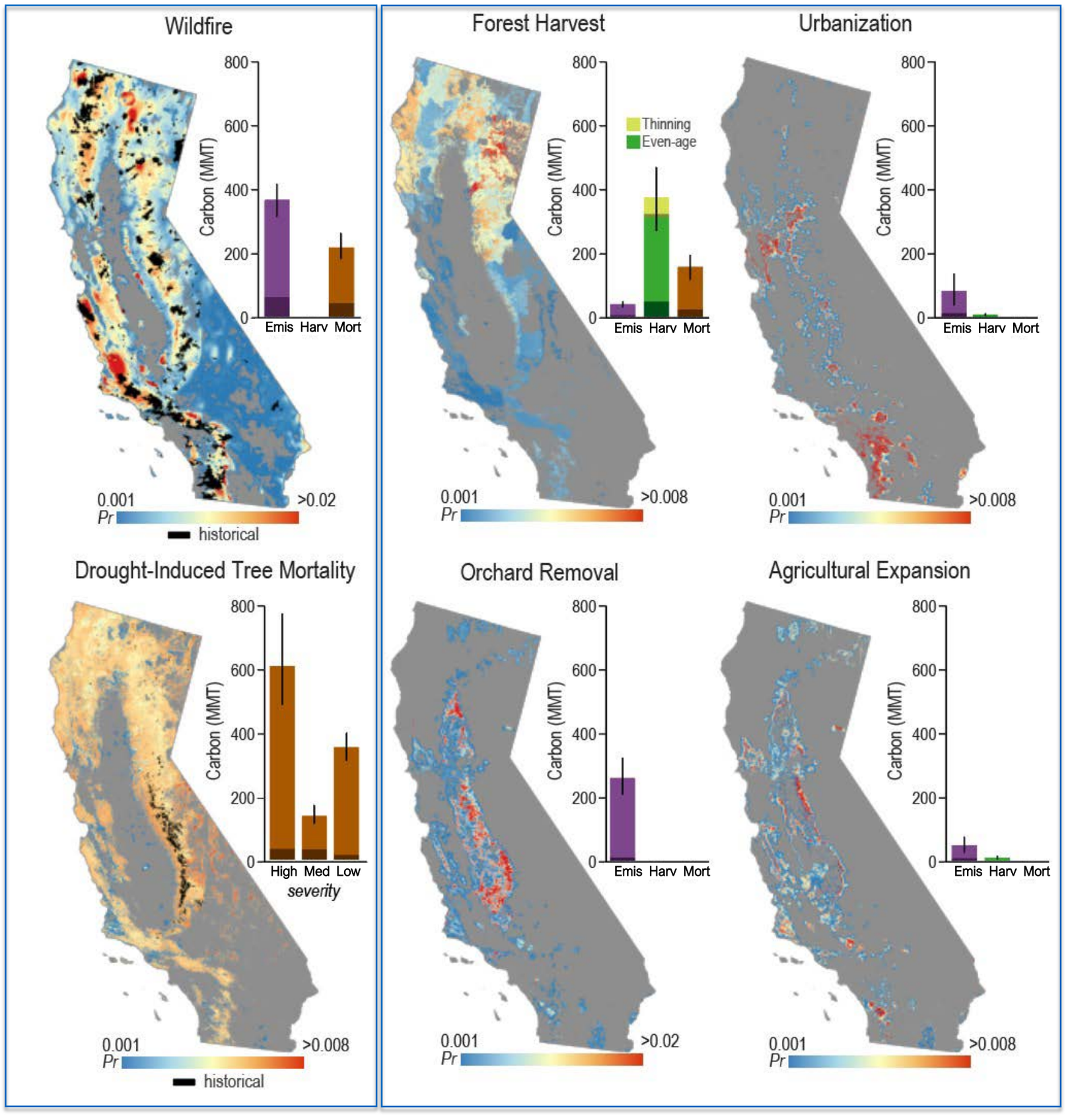
Sleeter et al.
In prep.

DRAFT

Drivers of carbon loss in California

Climate-related

Human-related



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Sleeter et al.
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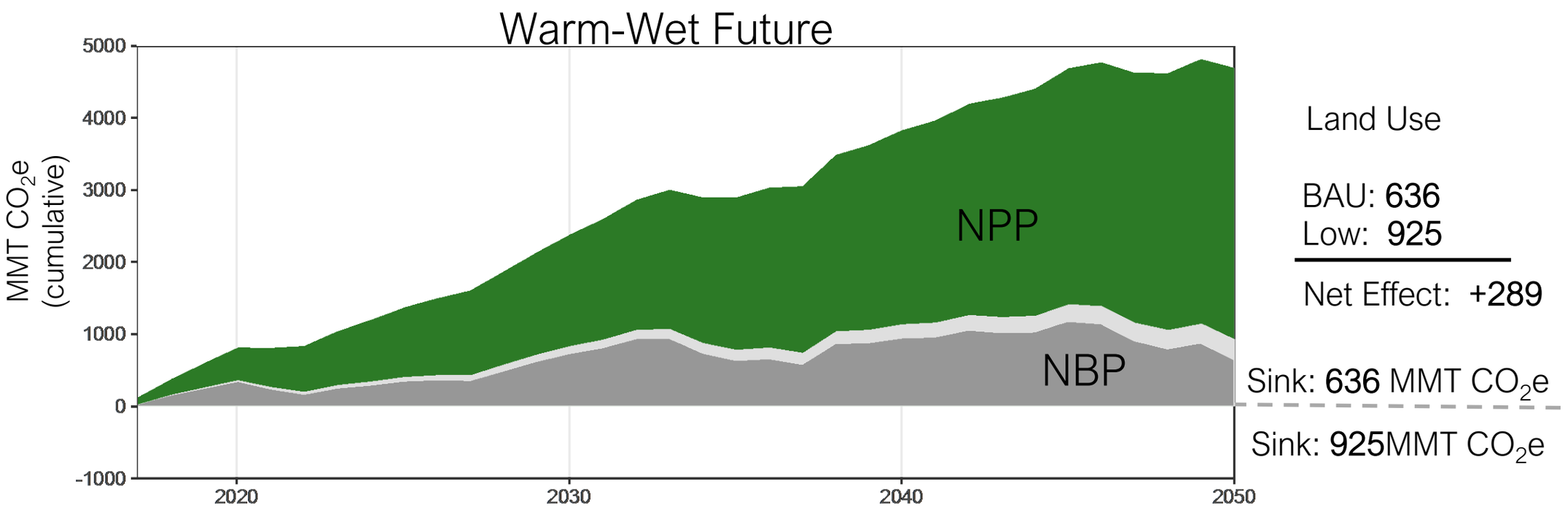
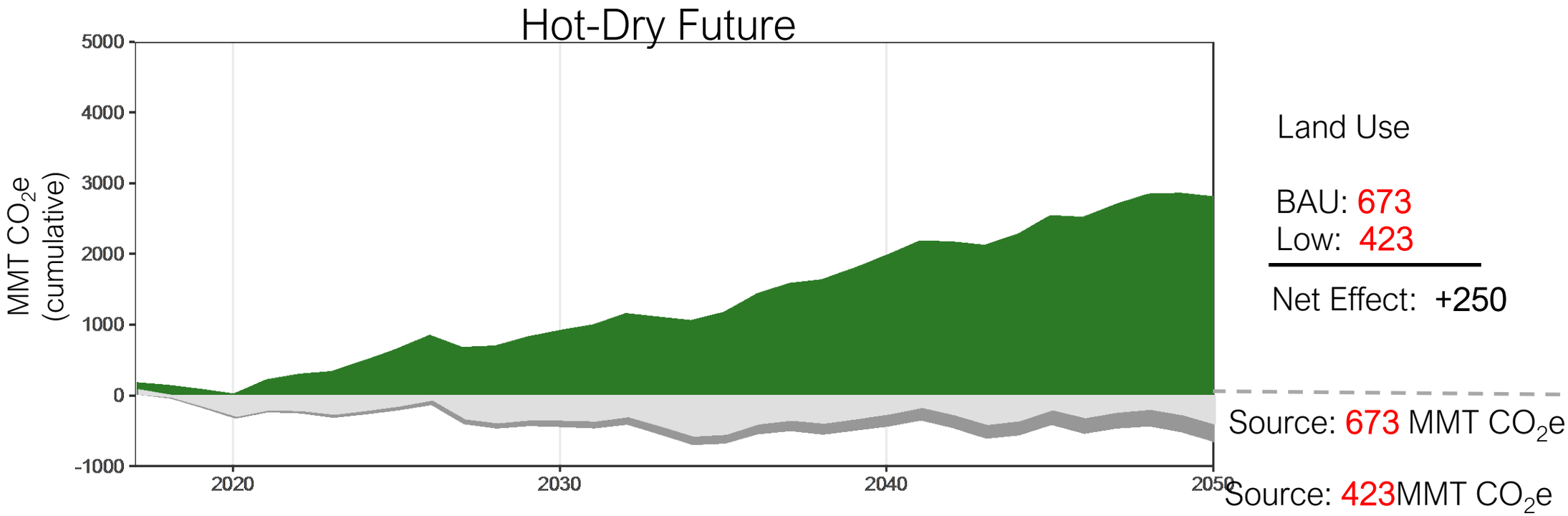
Land use provides consistent reduction potential under different climate futures





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