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Keeping it in the (carbon) bank: Working rangelands

- The setting
- The soils
- The plants
- The sites
- Fire and water
- The land
- Multipurpose management

……and carbon stocks

What’s in the bank?

- Grasslands may be more reliable carbon sinks than forests in California (Dass et al. 2018)(Chang et al. 2020)
- More than half of California is rangeland
- Oak woodlands alone store 675 MMT, and sequester 3 MMT per year.
- Rangelands store approximately 30 percent of the world’s terrestrial carbon stocks
- Climate change is likely to reduce carbon storage in rangelands

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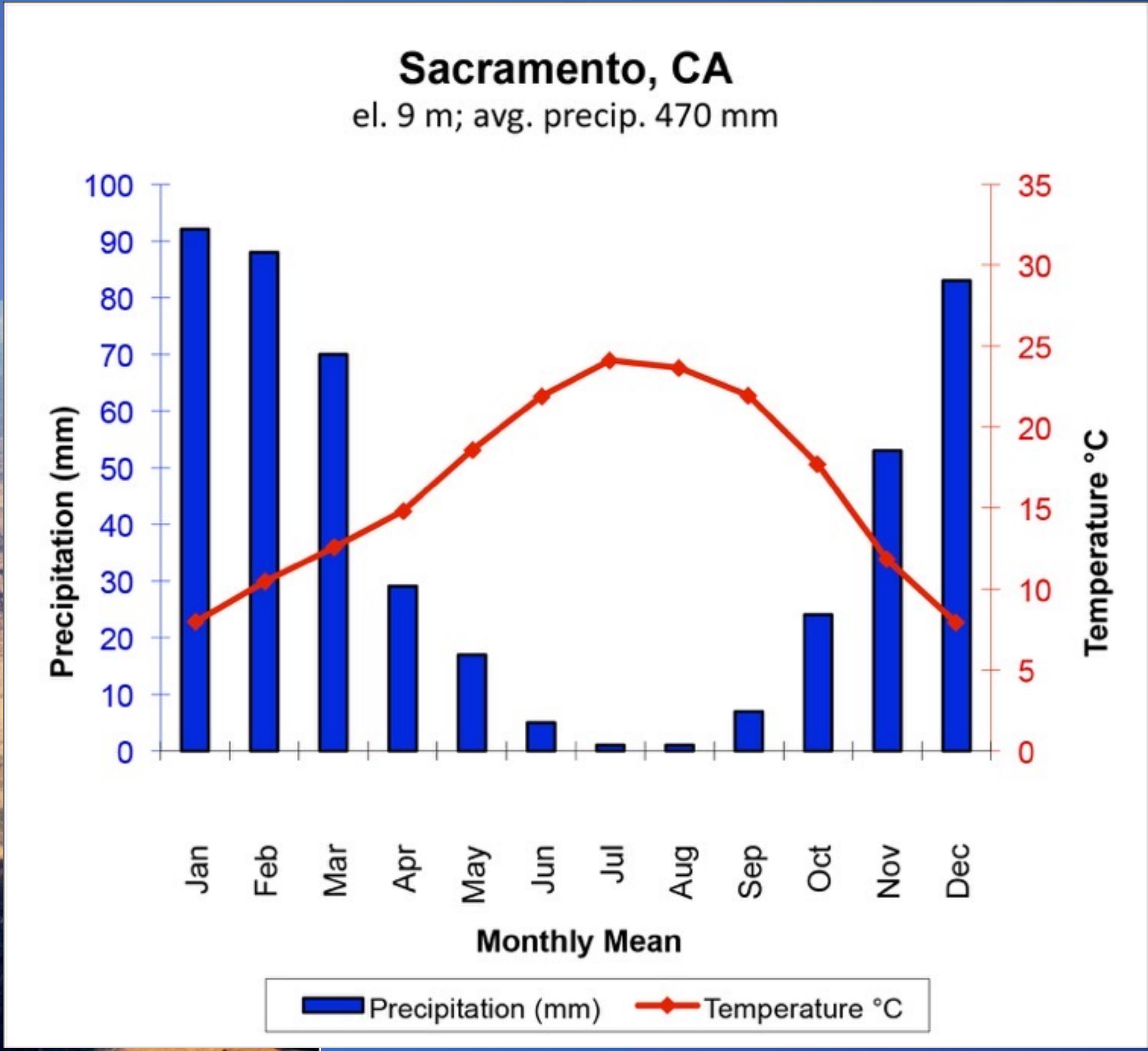
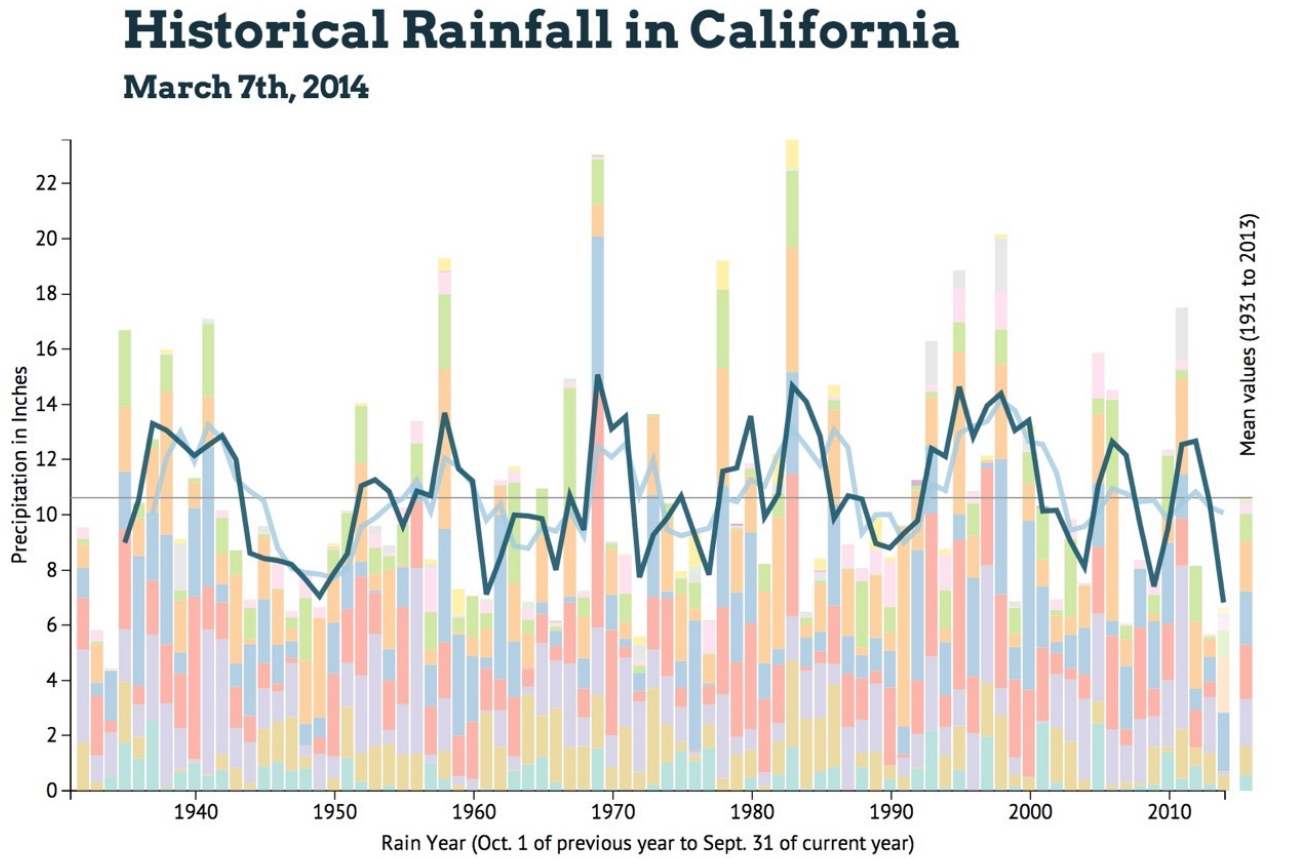
Summer drought





	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1960:	0.09	2.75	0.07	1.52	0.4	1.04	0.57	0.4	0.01	0	0.1	0	6.95

Grassland production ranges from about 500kg/h to 3,000 kg/ha, with rainfall timing, pattern, and amount, + temperatures

California rangelands

For a given site, patterns of….

- RAINFALL
- TEMPERATURES
- FIRE
- GRAZING
- NITROGEN DEPOSITION
- ??

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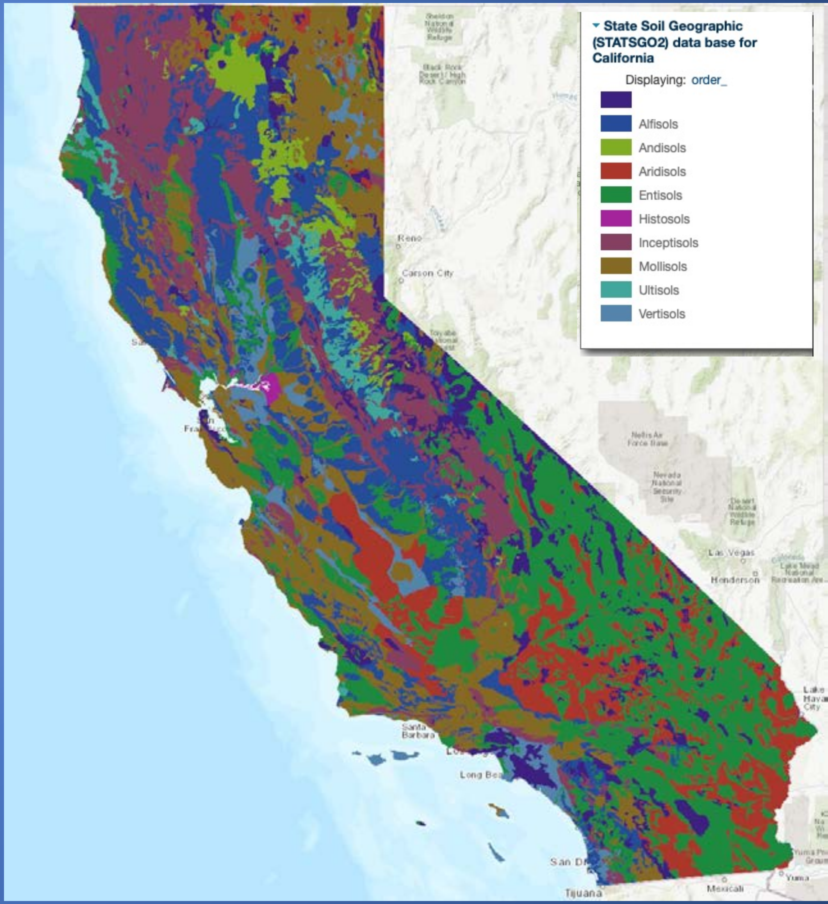


Soils and carbon stocks

- Soil carbon is highly variable
- Annual grasslands have similar soil storage capacity to temperate perennial grasslands.
- In general, grazing not well linked
- Clay soils higher
- Relation with productivity seems to vary
- Varies with temperatures, timing of precipitation

(Carey et al. 2020, Silver et al. 2010, Veloz et al. 2022, Chou et al. 2011)

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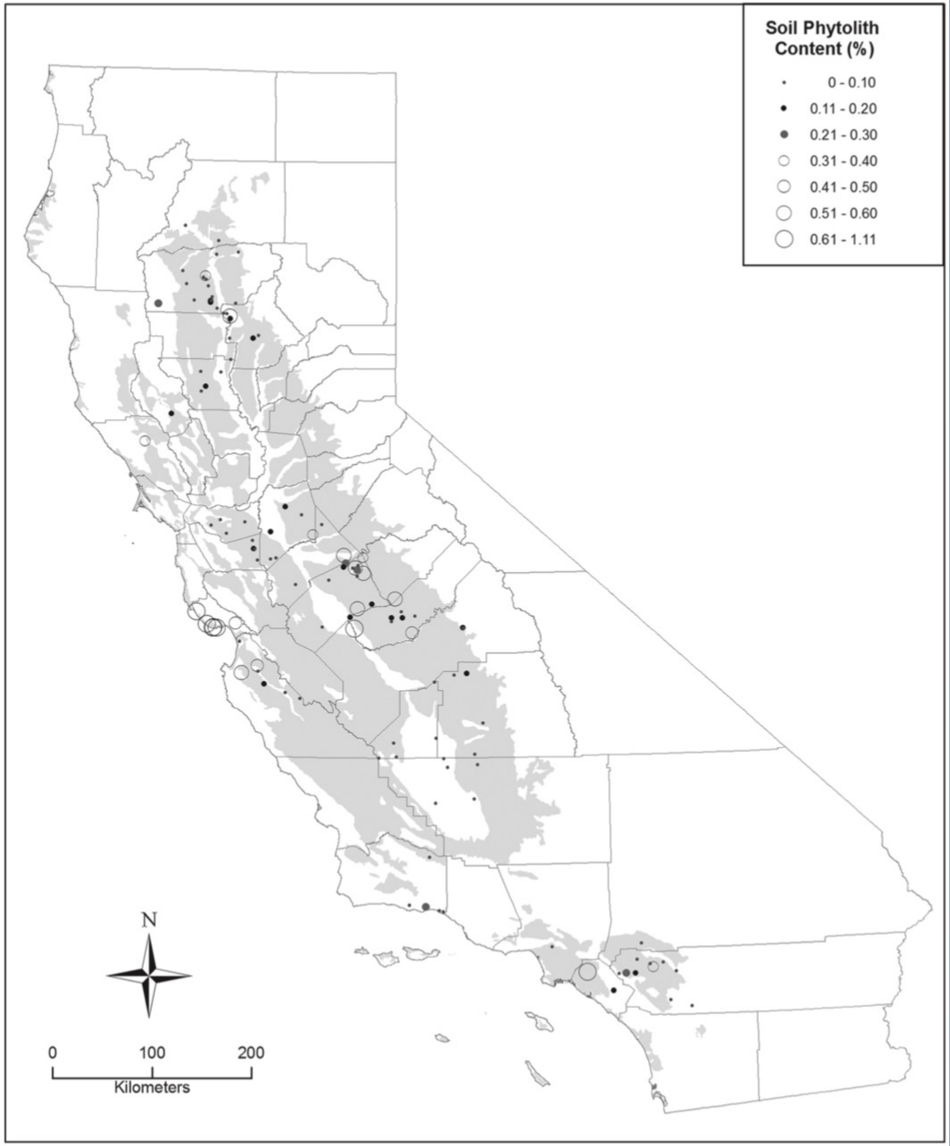
Decades without livestock, but no return of native perennials, only wild oats

Dumbbell-shaped opal phytoliths in foothill needlegrass (*Stipa lepida*) leaf

Phytolyth evidence: lack of perennial grasses in drier areas of state



Evett and Bartolome 2017


Annual forb-dominated grassland,
Antelope Valley, CA

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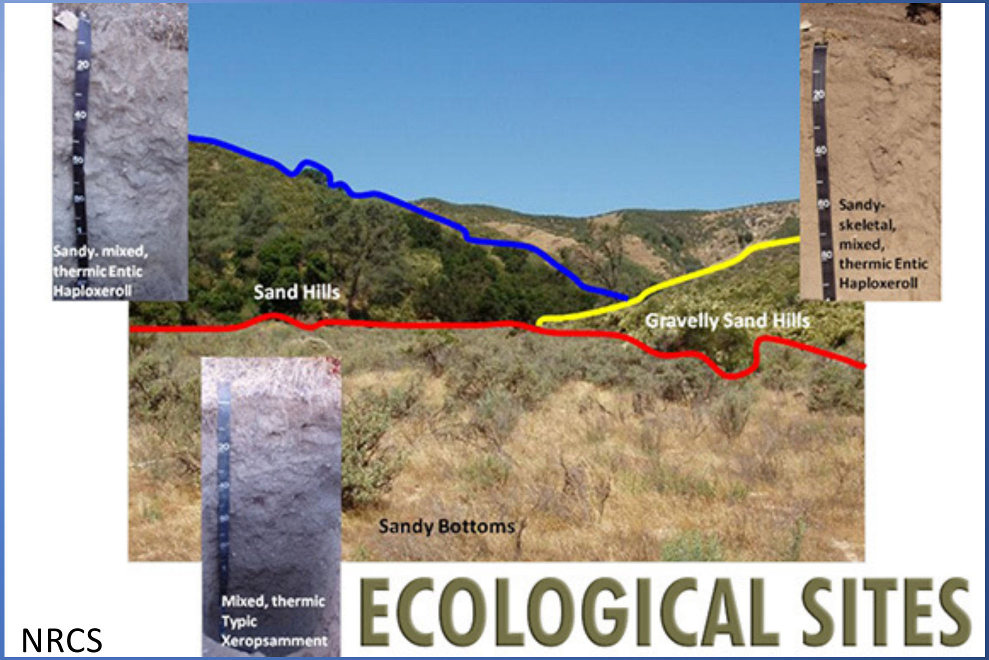
The specifics of site are important:
example-- Ecological Site Descriptions (ESD)

An ecological site is defined as a distinctive kind of land with specific soil and physical characteristics that differ from other kinds of land in its ability to produce a distinctive kind and amount of vegetation and its ability to respond similarly to management actions and natural disturbances. An ESD describes the ecological site.

- Defined area
- Soils, topography, climate
- Site history (fire, cultivation, etc)
- Site may explain inconsistencies in relationships of management and other variables with soil carbon stocks.



Grazing management principles to attain desired outcomes for an ecological site: Goals vary!

1. **Kind and class** of livestock used
2. **Spatial distribution** of animals
3. **Temporal distribution** of animals
4. **Number** of animals per unit area

[Constrained by weather of course]

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Untangling all the variables: California natural and working lands carbon and greenhouse gas model (Simmonds et al. 2021)

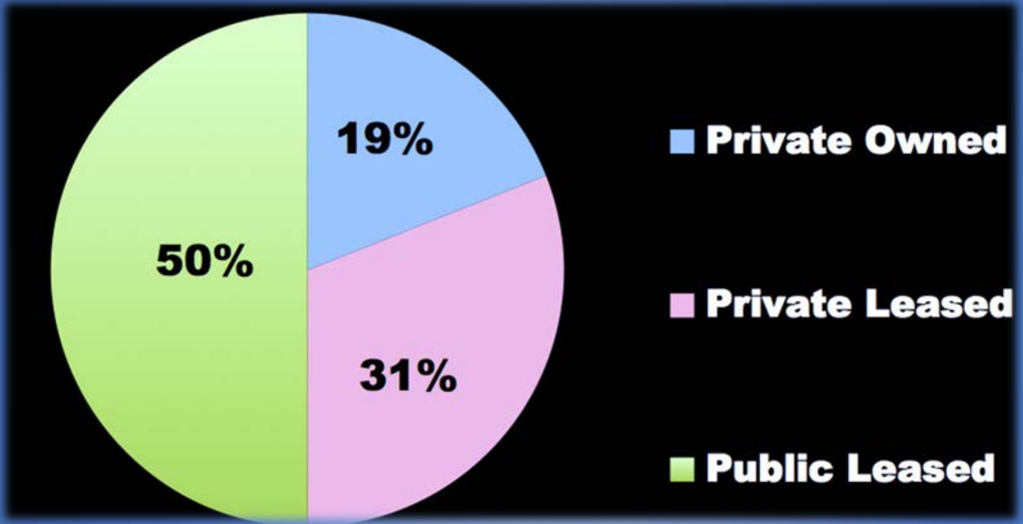
The main sources of emissions reductions for rangelands were from enhanced ecosystem carbon storage, avoided urban expansion (i.e. land protection), and avoided high-severity wildfire (Simmonds 2021 Caland model)

Avoid conversion: predicted loss of 2 m acres by 2050

- Ranches—about 60% of rangelands owned by ranchers
- Conservation easements
- Public lands (local more nimble): providing a forage resource
- Interdependence, East Bay 30%(?).

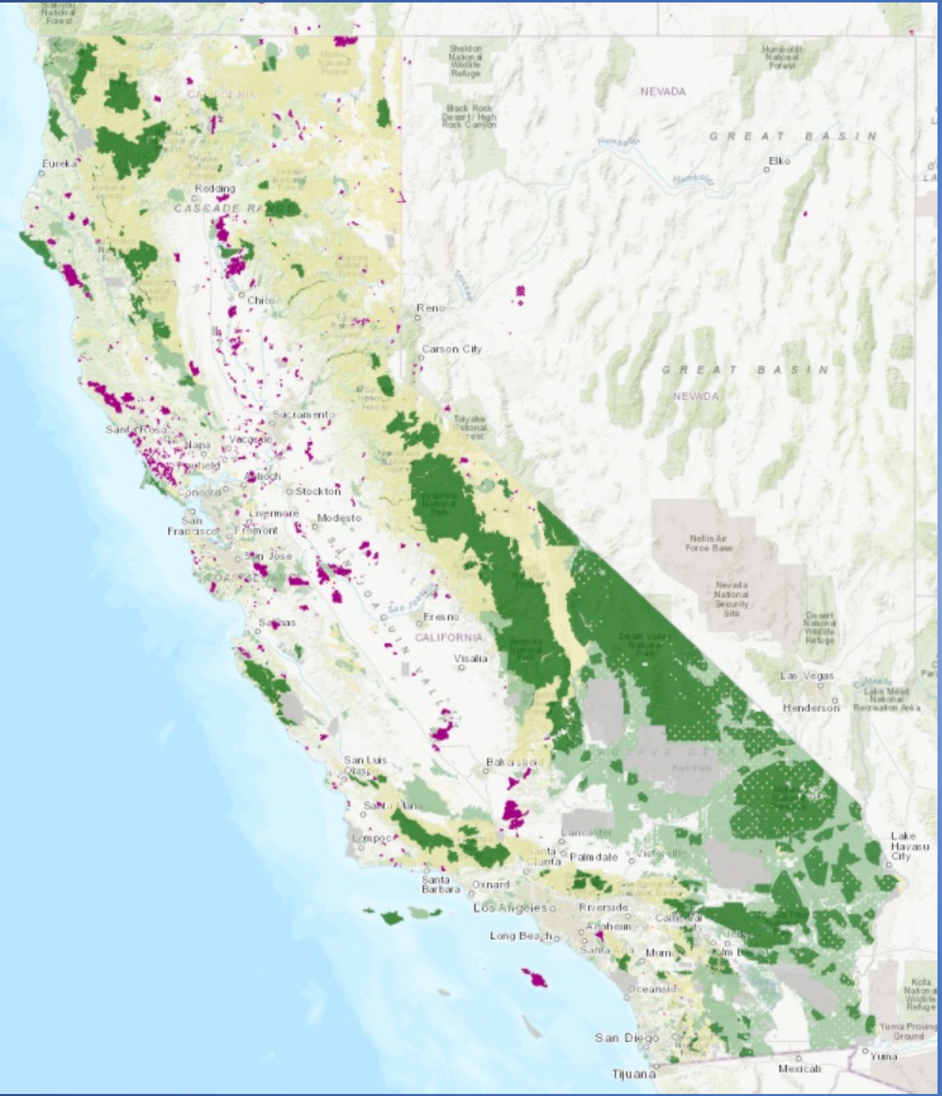
A typical East Bay ranch

(Sulak 2007)



--Competition for public leases is fierce as the forage base shrinks.

--Used 4 private leases on average, one used 15 private and public



California conservation easements

If current trends continue, 2 million acres more of farm and ranch lands - and their benefits - will be lost to conversion by 2050 (Am Farmland Trust 2020).

Conservation Biology Institute 2015

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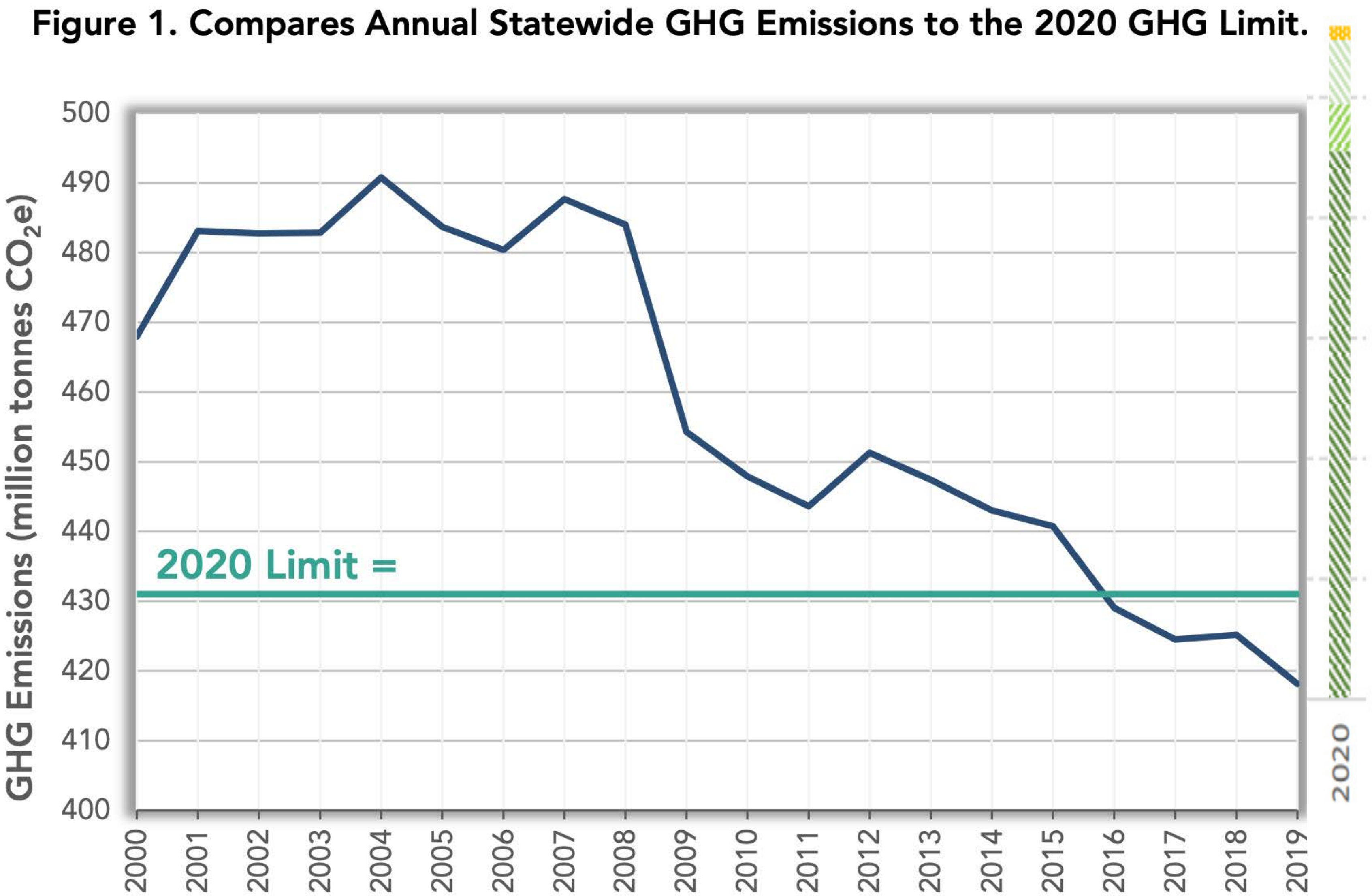
Restore and protect oaks on suitable sites

- Islands of fertility
- Greatest amount of carbon in grasslands is an oak tree
- Oak woodlands: 675 MMT stored

- What about fire?
- What about drought?
- How to increase stability?

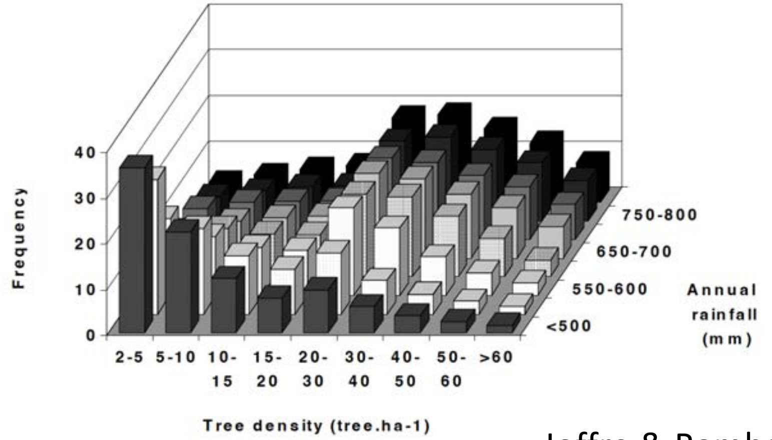


Wildfire CO2 emissions 2020 (CARB inventory)

High rainfall: 60+ oaks per ha

Low rainfall: 2-5 oaks per ha

Most fire-resistant landscape in Spain (Ortega et al. 2012)



Joffre & Rambal 1997

Figure 10. Frequency distribution of tree density against mean annual rainfall, Sevilla, Spain.

Drought mortality with low water table
Suitable site crucial

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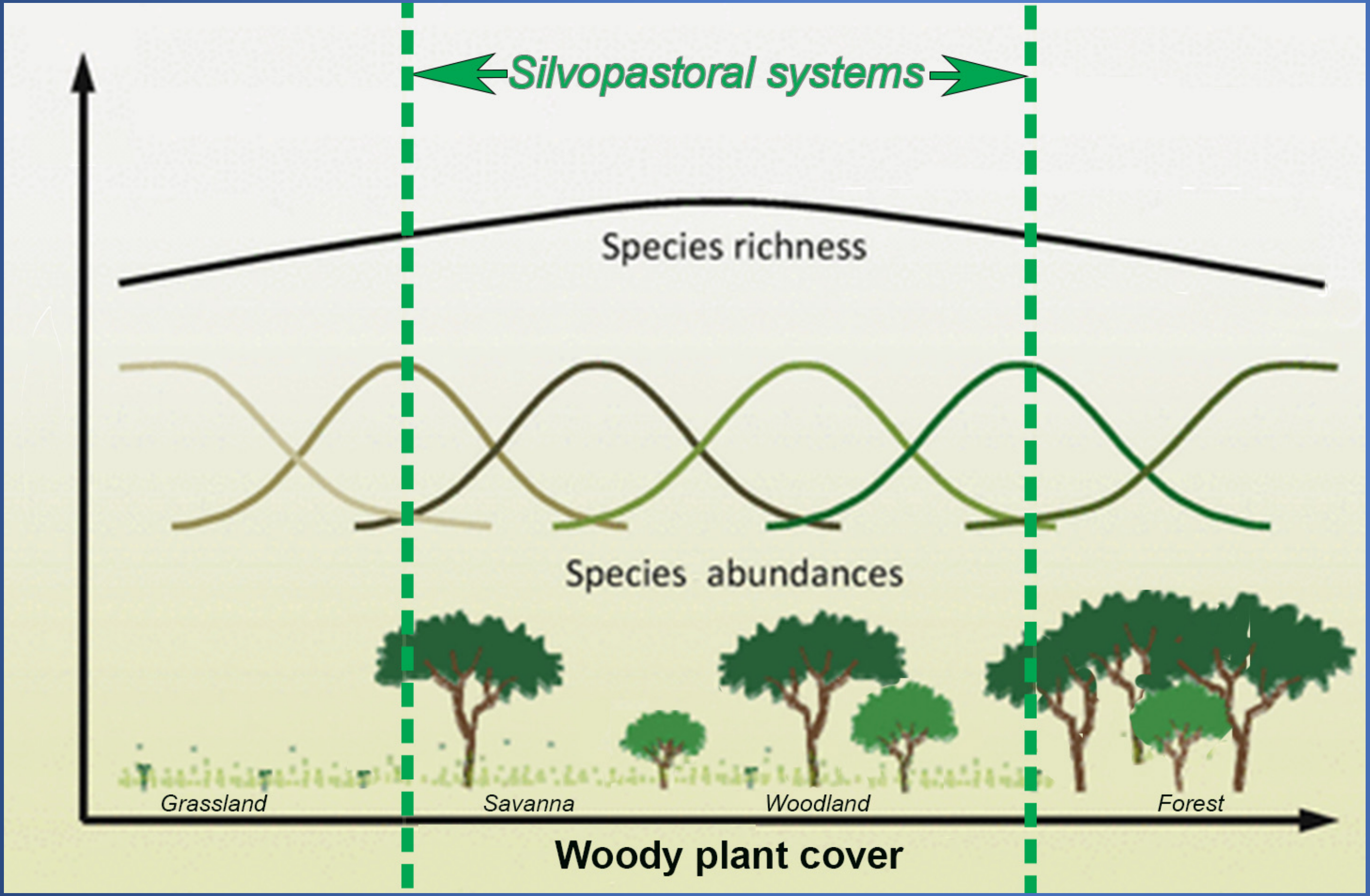
Increase stability of oak carbon pools



Manage density and continuity of woody vegetation spacing & patchiness:

Fire & water

Archer,

Grazing & ranching have multiple purposes in a multi-purpose landscape:

- Reduce fuels and protect carbon (11 billion pounds a year, Ratcliff in press)
- Protect soils and carbon, and forage production
- Maintain benefits of control burning and protect carbon
- Improve wildlife habitat and protect carbon: 59% of listed wildlife and plant species on rangelands actively benefit from grazing (Barry and Huntsinger 2022)
- Reduce “thatch” and manage vegetation structure and protect carbon and increase forage production
- Benefit pollinators, reduce influence of car exhaust and protect carbon
- Consume invasive plants and protect carbon
- Provide healthy food and protect carbon
- Reduce use of fossil fuels and reduce emissions.
- Eyes on the land and carbon protection