Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

Presentation and Discussion Notes from the First Roundtable: March 6, 2009

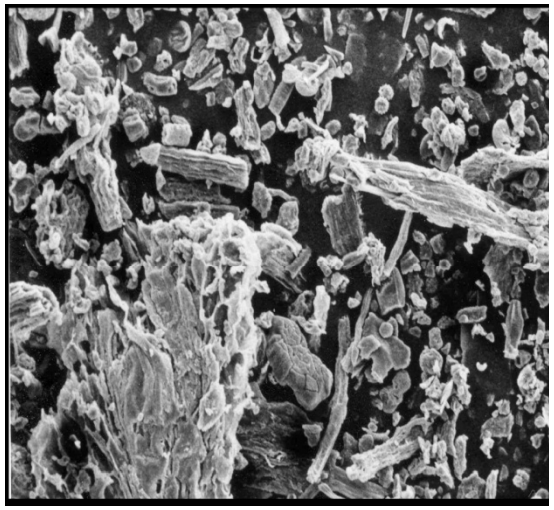
WHENDEE SILVER
SOIL CARBON POOLS IN CALIFORNIA RANGELAND SOILS: IMPLICATIONS FOR CARBON SEQUESTRATION

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

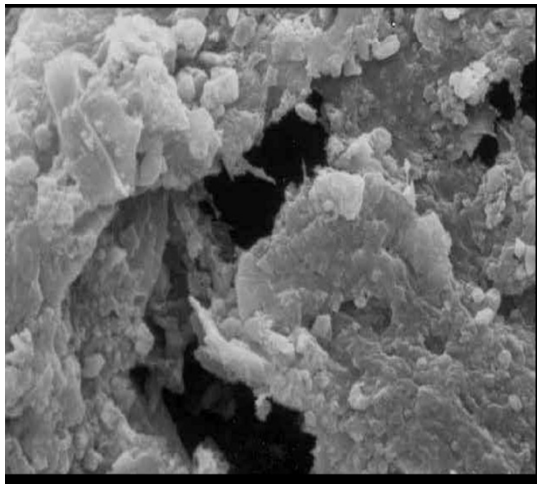
Part I:
Powerpoint Presentation by Whendee Silver

Soil Carbon Pools in California Rangeland Soils: Implications for Carbon Sequestration

Carbon generation



Carbon processing



Carbon storage

Rangeland Roundtable
Berkeley Institute for the Environment
March 6, 2009

Human activities have dramatically increased the atmospheric concentrations of greenhouse gases

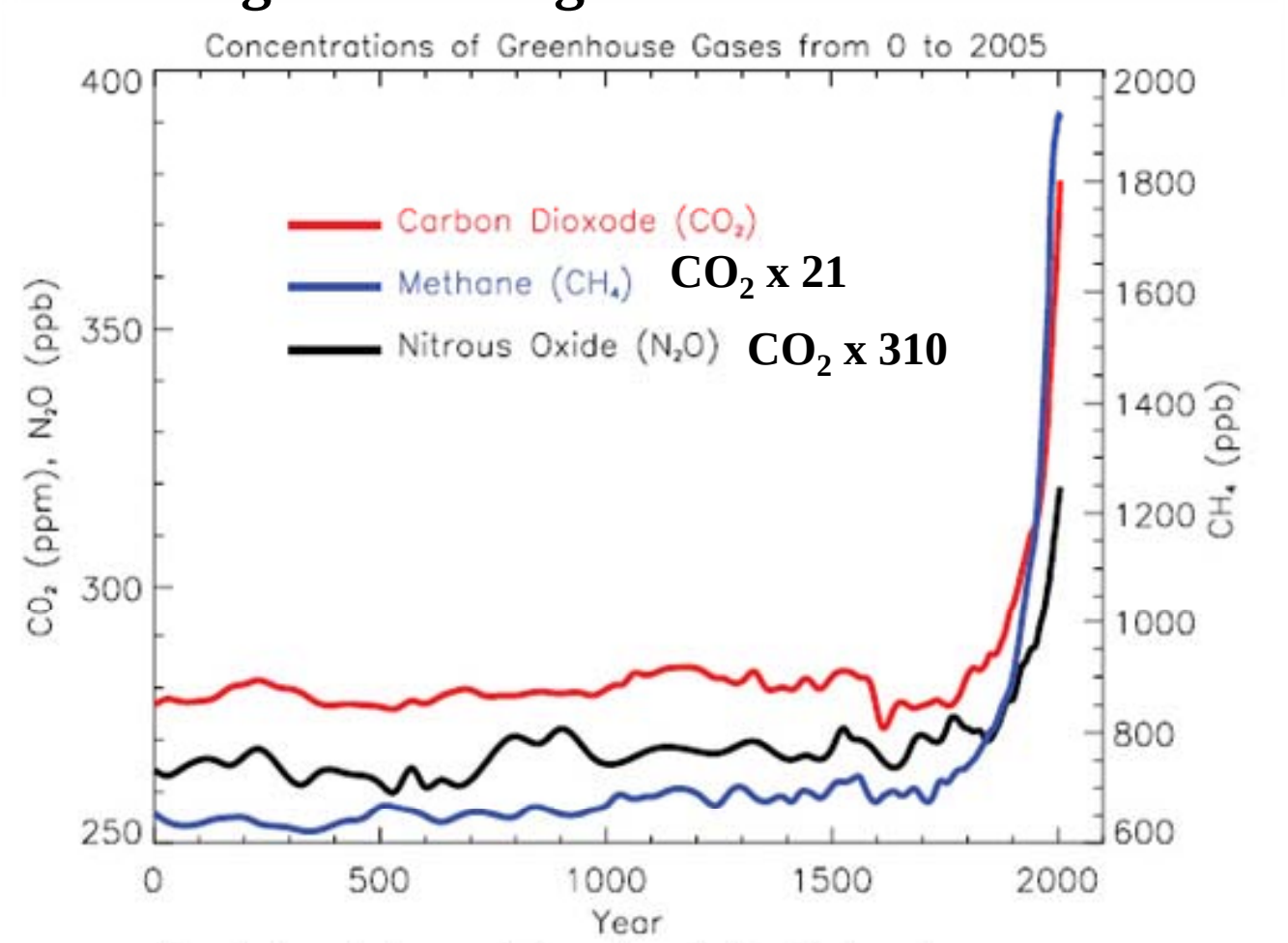
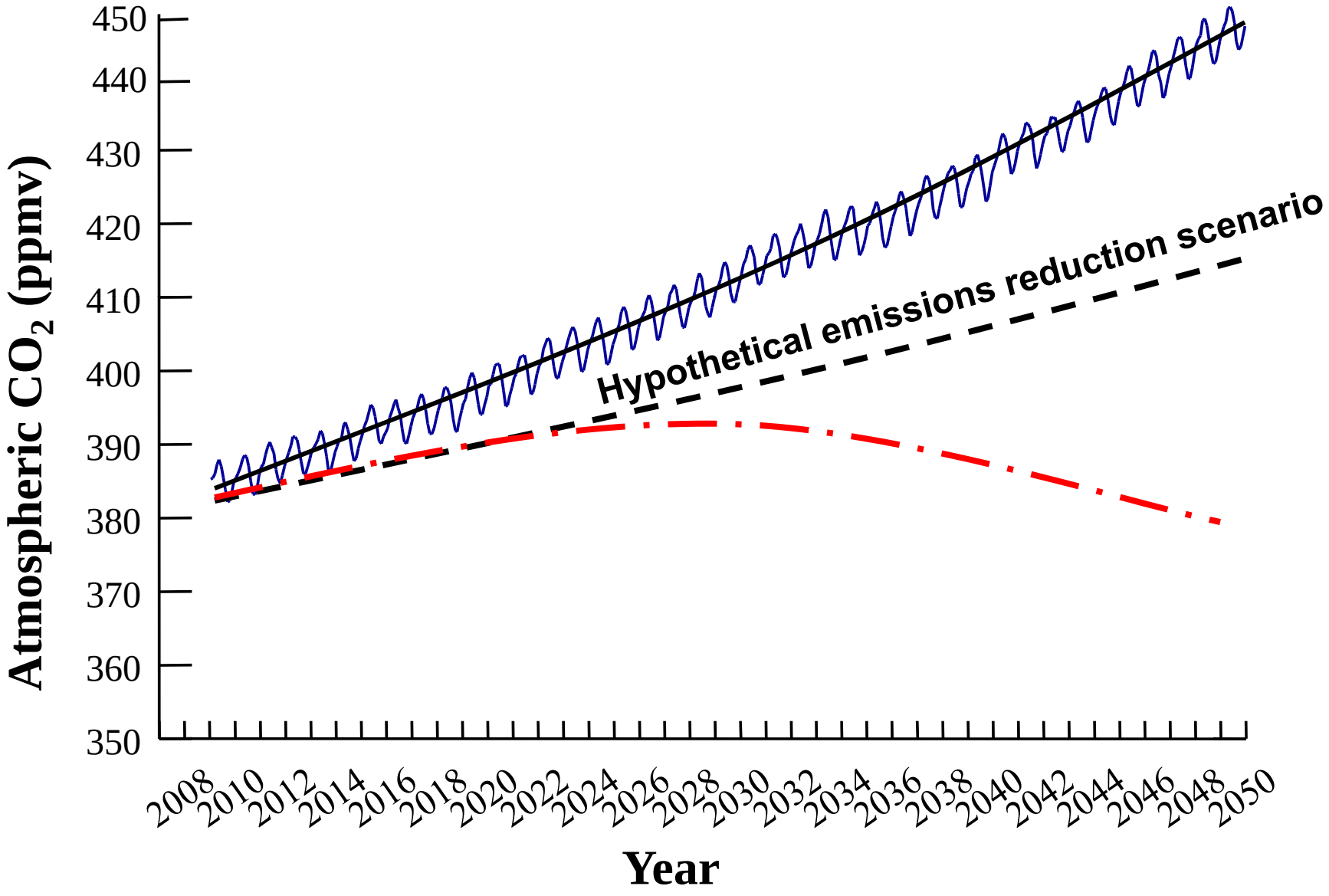
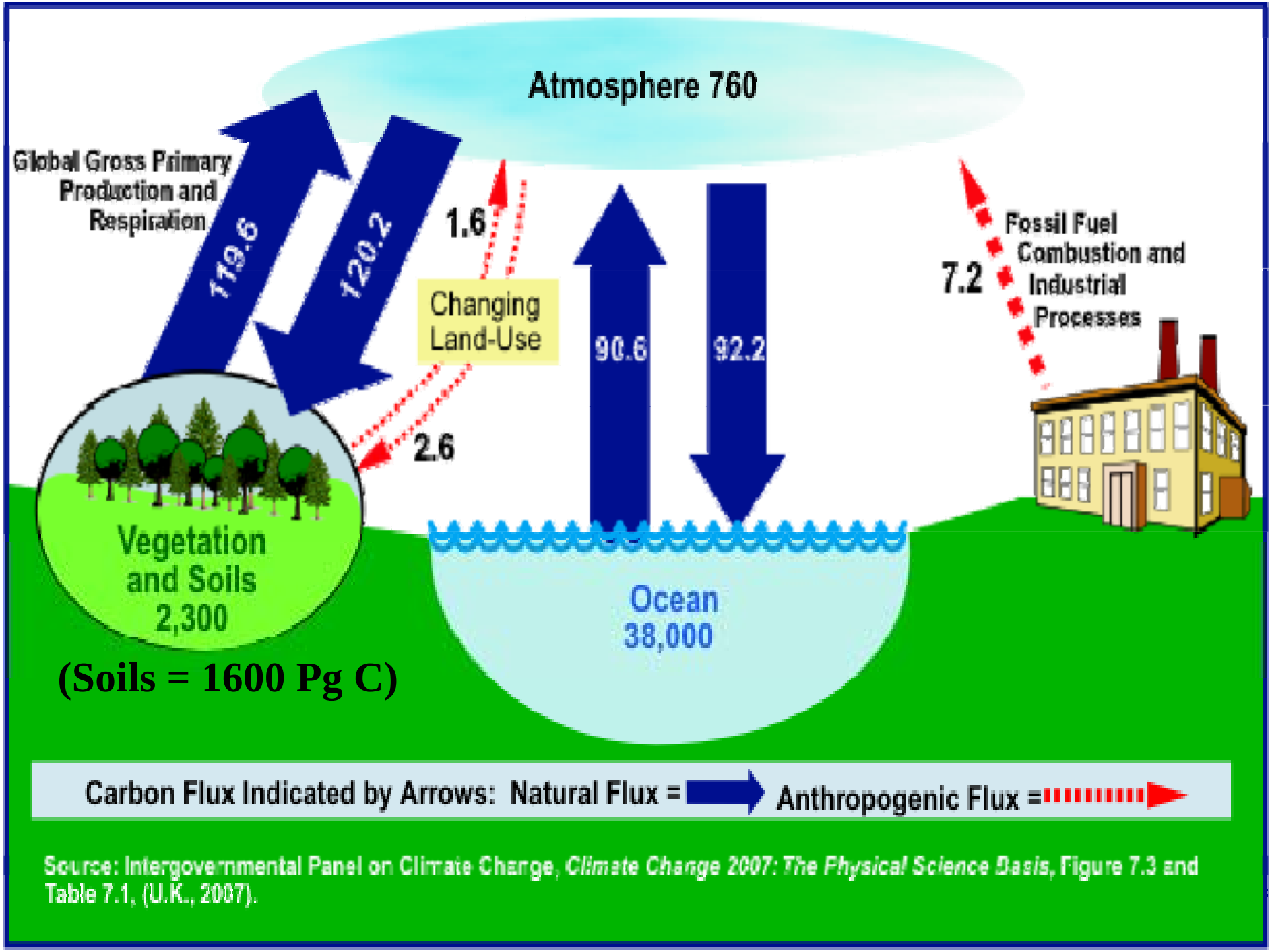


Figure 1. Atmospheric concentrations of important long-lived greenhouse gases over the last 2,000 years. Increases since about 1750 are attributed to human activities in the industrial era. Concentration units are parts per million (ppm) or parts per billion (ppb), indicating the number of molecules of the greenhouse gas per million or billion air molecules, respectively, in an atmospheric sample.

IPCC AR4 FAQ

Reducing emissions alone will not mitigate climate change

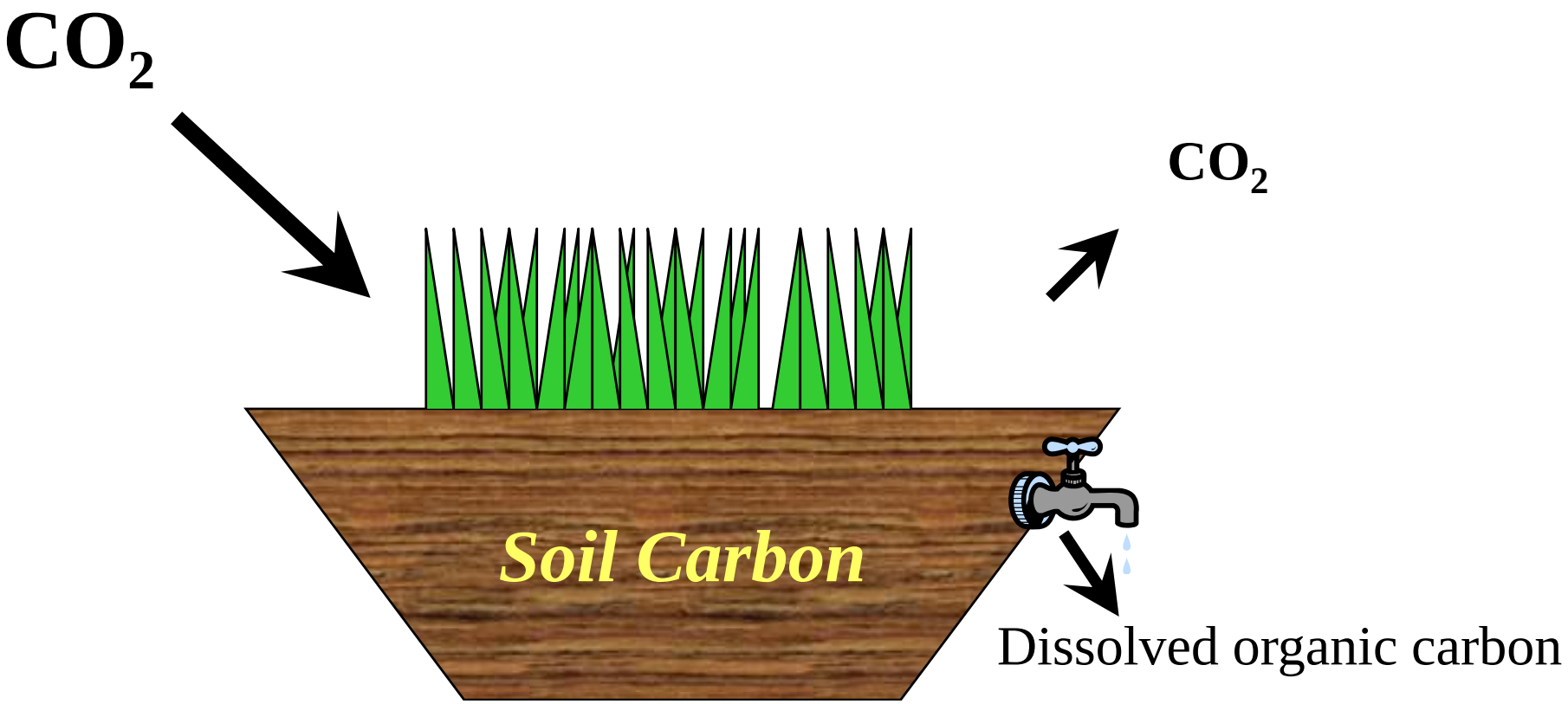




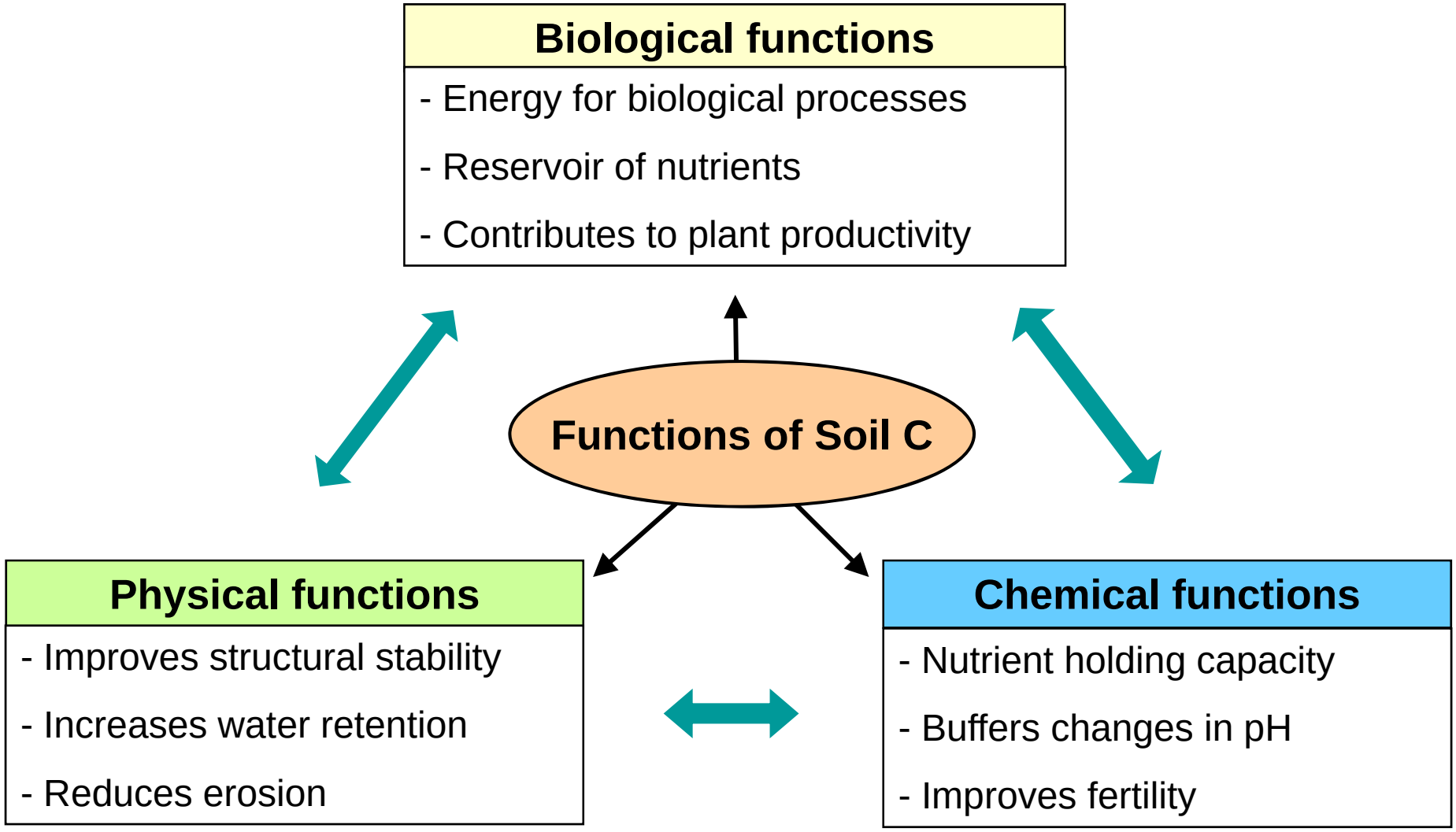
Source: Intergovernmental Panel on Climate Change, *Climate Change 2007: The Physical Science Basis*, Figure 7.3 and Table 7.1, (U.K., 2007).

Terrestrial Carbon Sequestration :

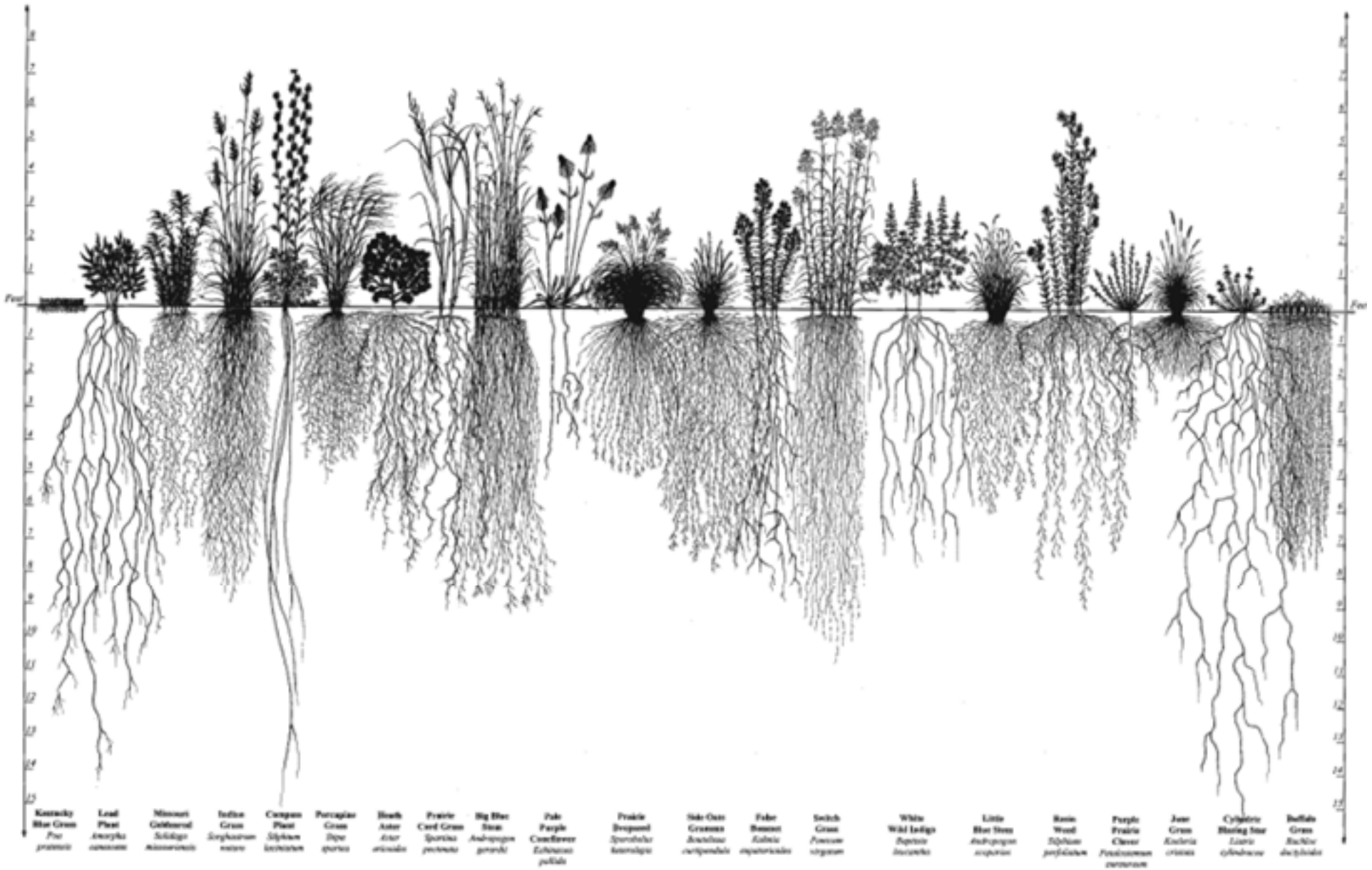
Carbon Inputs > Carbon Losses



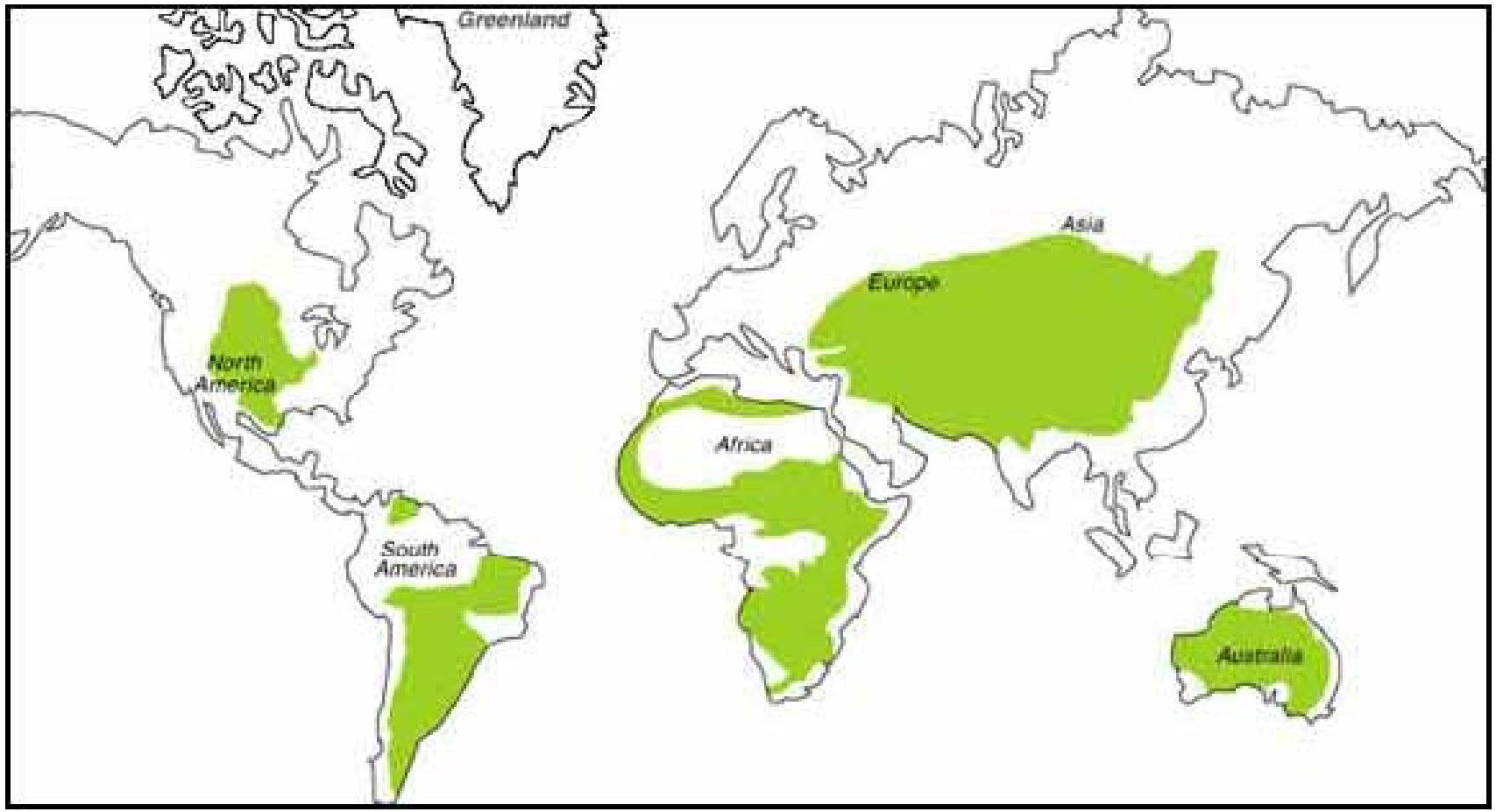
Soil Carbon Sequestration: Many Co-Benefits



Grasses allocate a high proportion of their photosynthate belowground to roots ➔ greater soil carbon pools



Carbon sequestration: Grasslands



***30% of global land surface *Over half of the global land use**
***55% of the US land area *56% of CA land area**

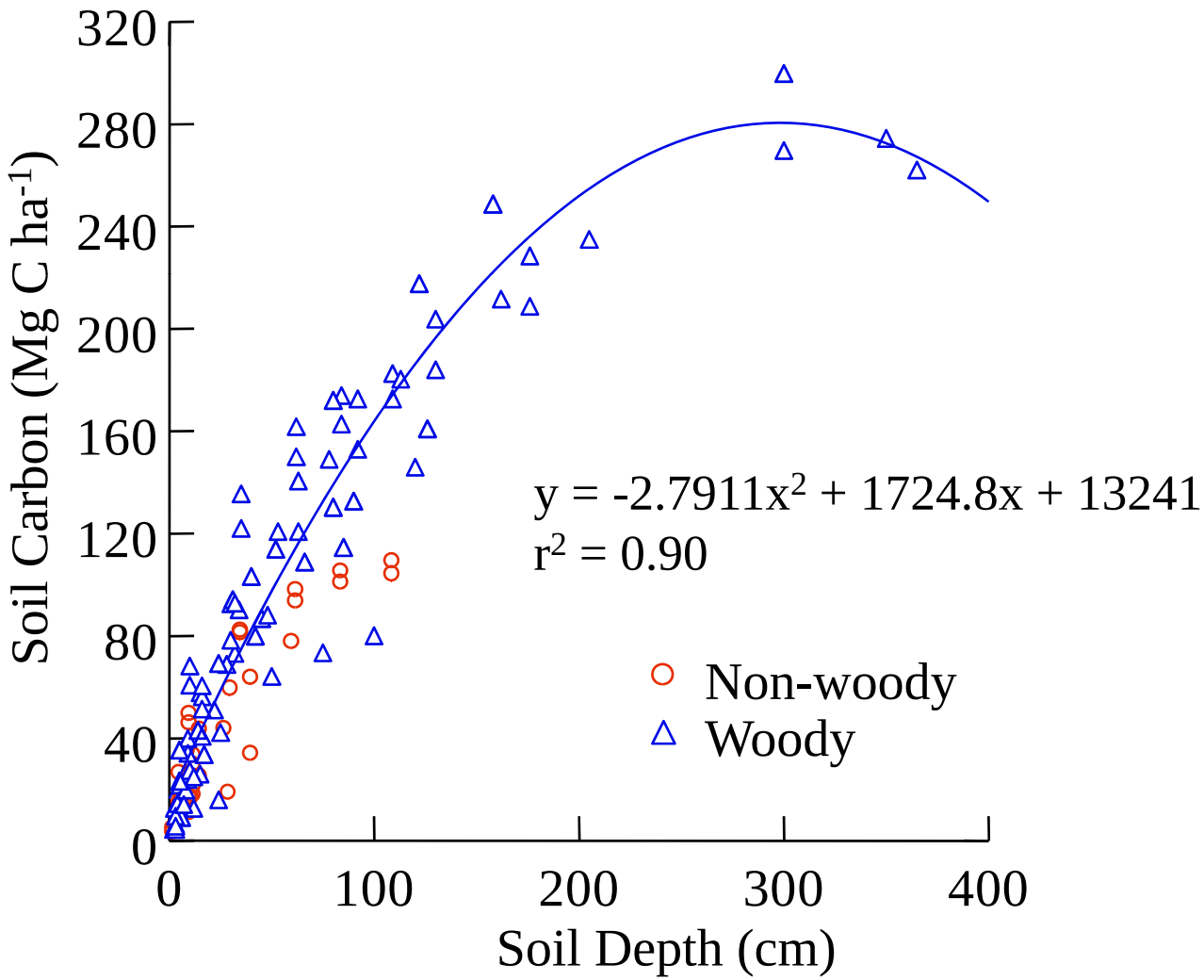
Marin Carbon Project
Phase I
(UCB, land owners, range managers, UC extension, MALT)

Is it possible to sequester carbon in rangeland soils?

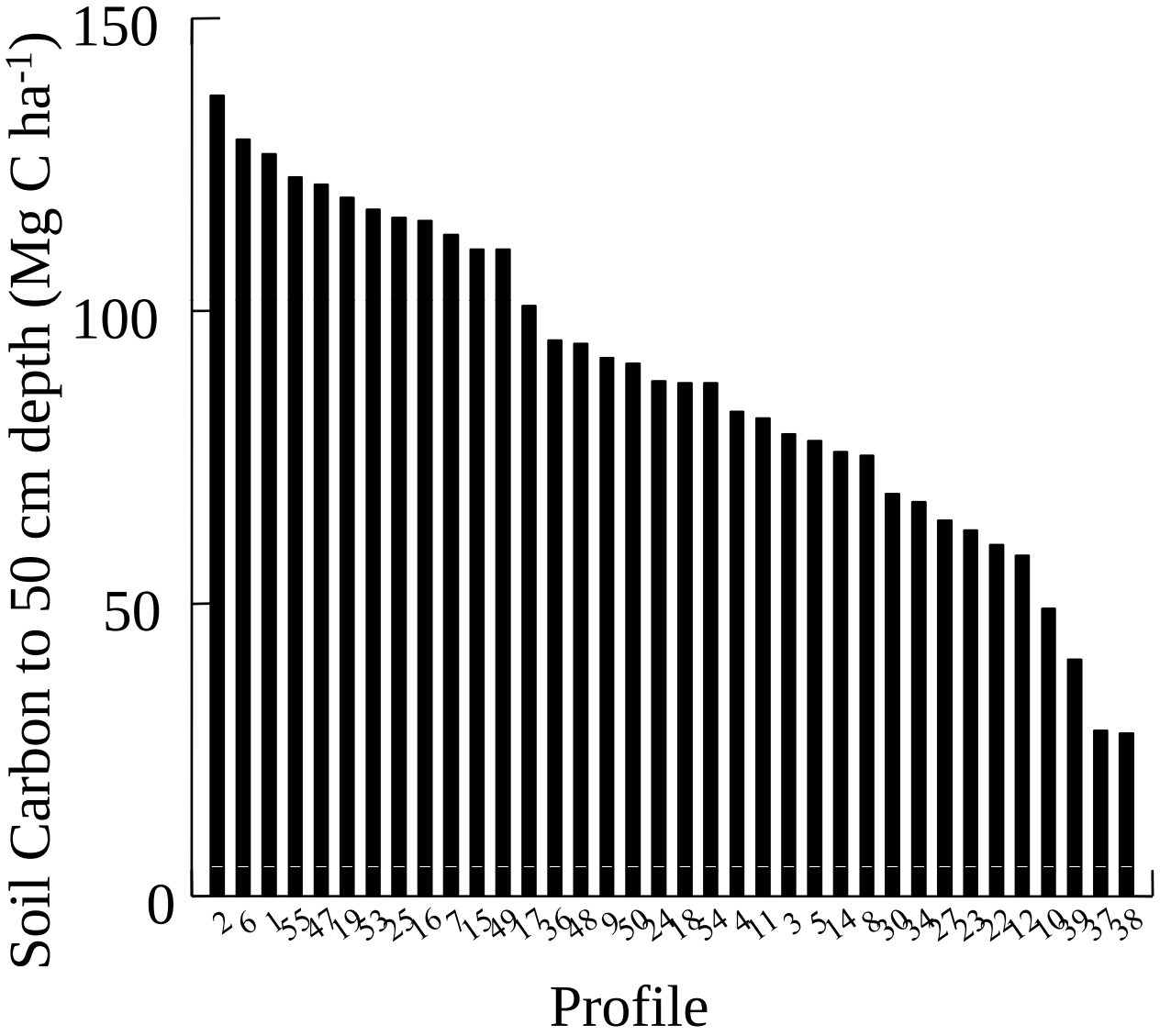
1. ***Determine the amount of carbon in California's rangeland soils; examine potential relationships with climate, soil type, management, and cover type.***

2. ***Determine the amount of carbon in Marin County's rangeland soils; explore relationships with soil type, management, and cover type.***

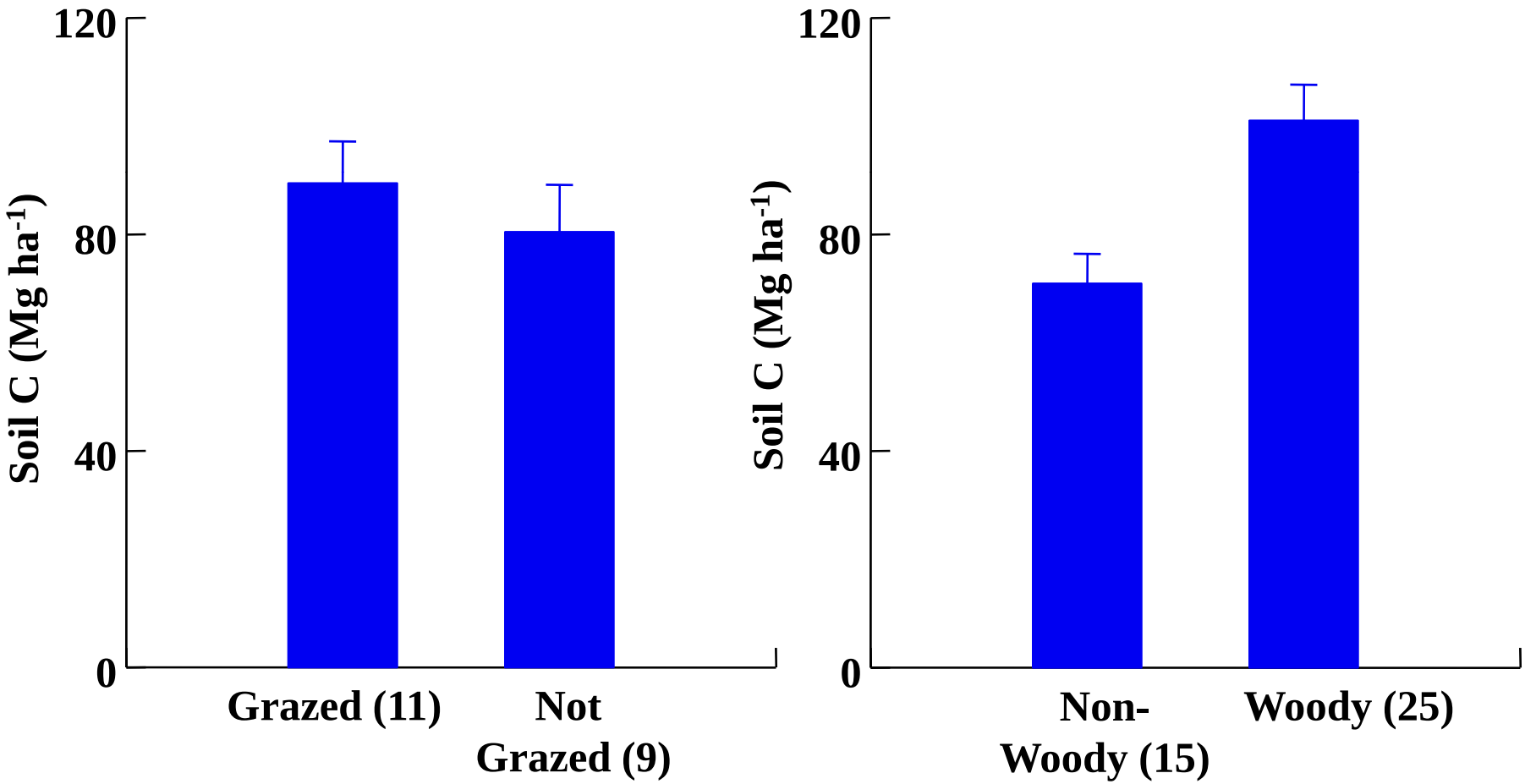
Cumulative soil carbon pools by depth in California rangeland soils.



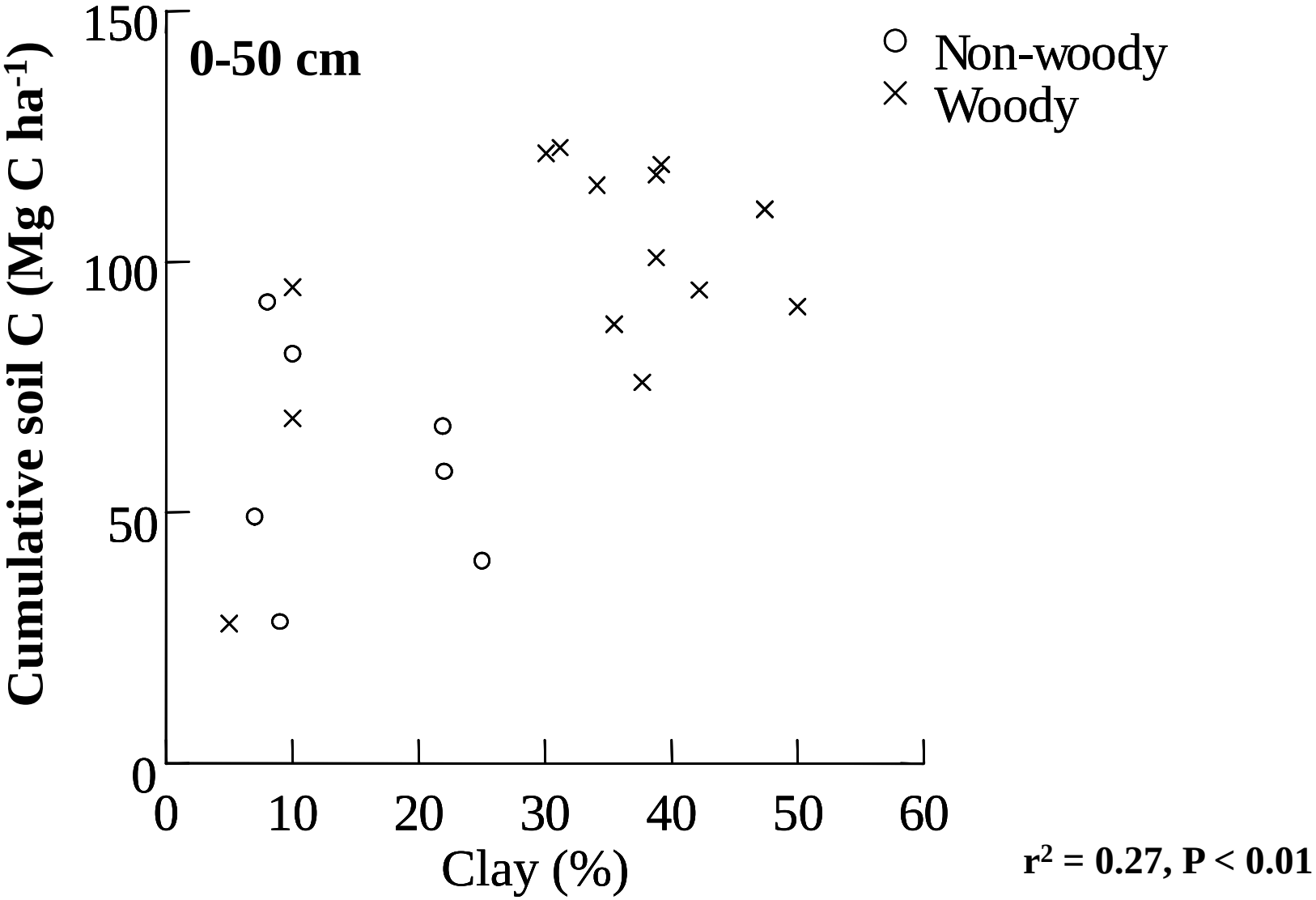
- **Large range in soil carbon pool size**
- **Considerable soil C storage capacity**



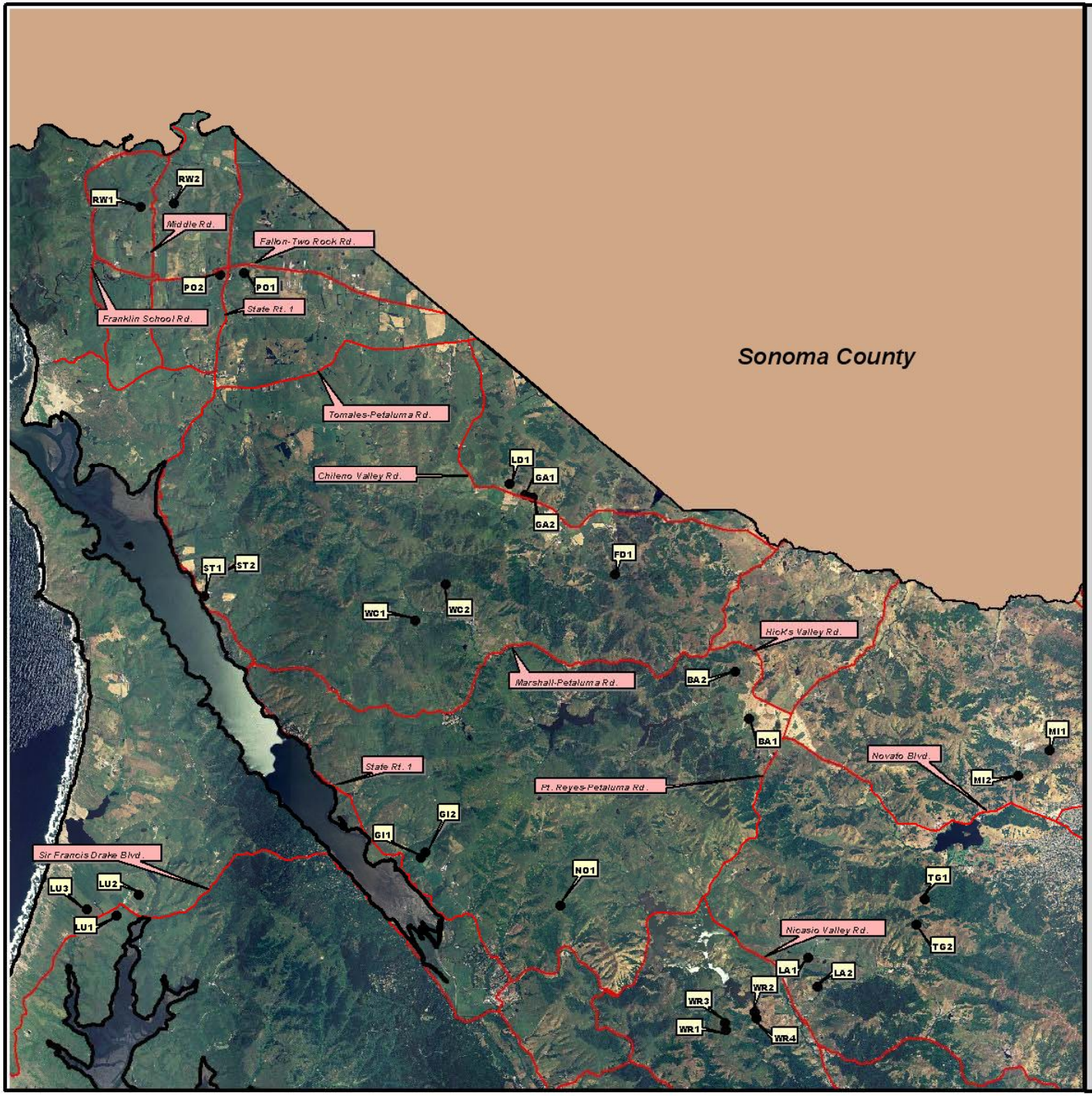
Grazing had no detectable impact on soil C pools
Woody plants increased rangeland soil C by approximately 30%



Soil C is weakly correlated with clay content



$r^2 = 0.27$, $P < 0.01$



West Marin Carbon Project
Marin County Field Sites

2 0 2 4 Miles

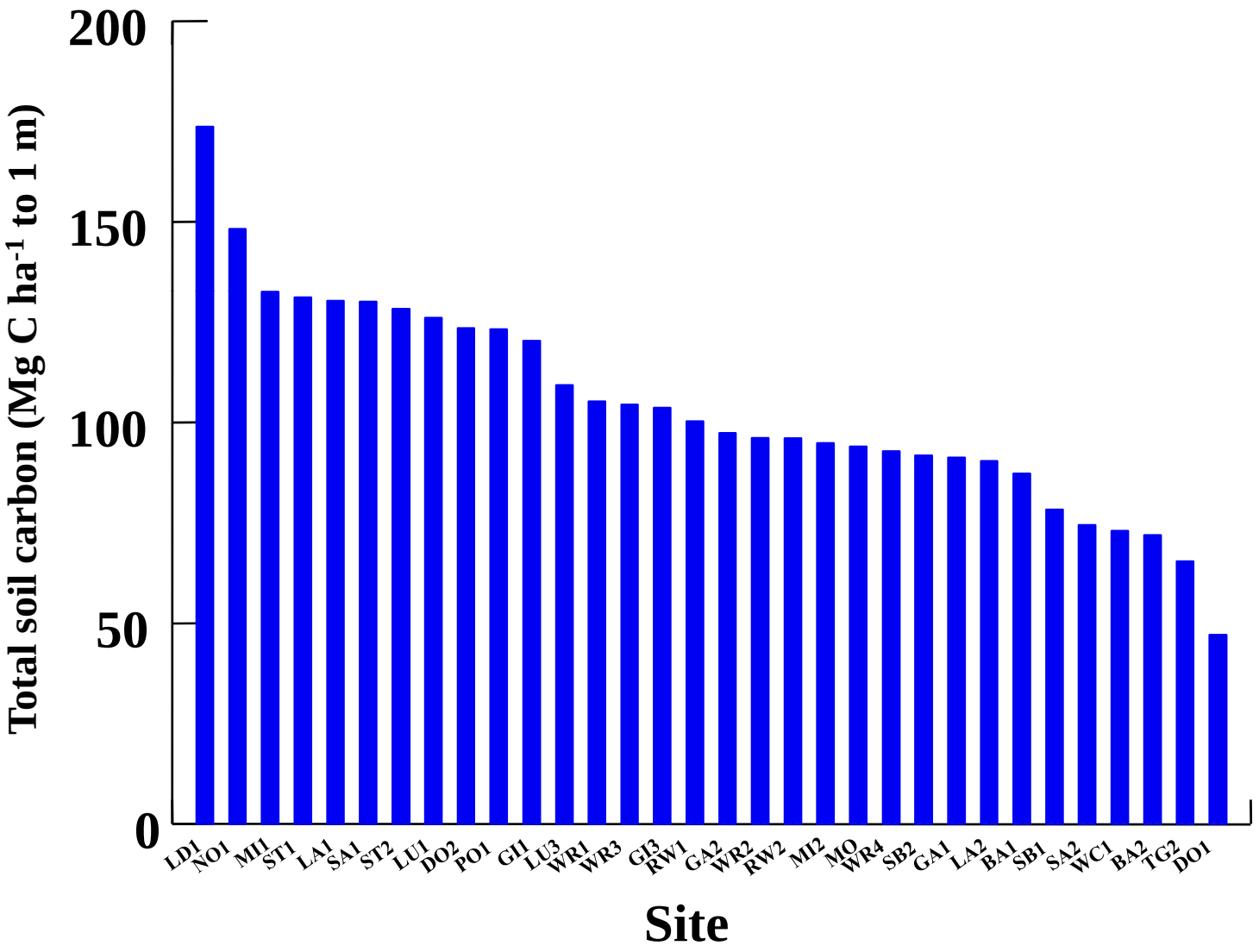
1 inch = 14,000 feet

MARIN AGRICULTURAL LAND TRUST

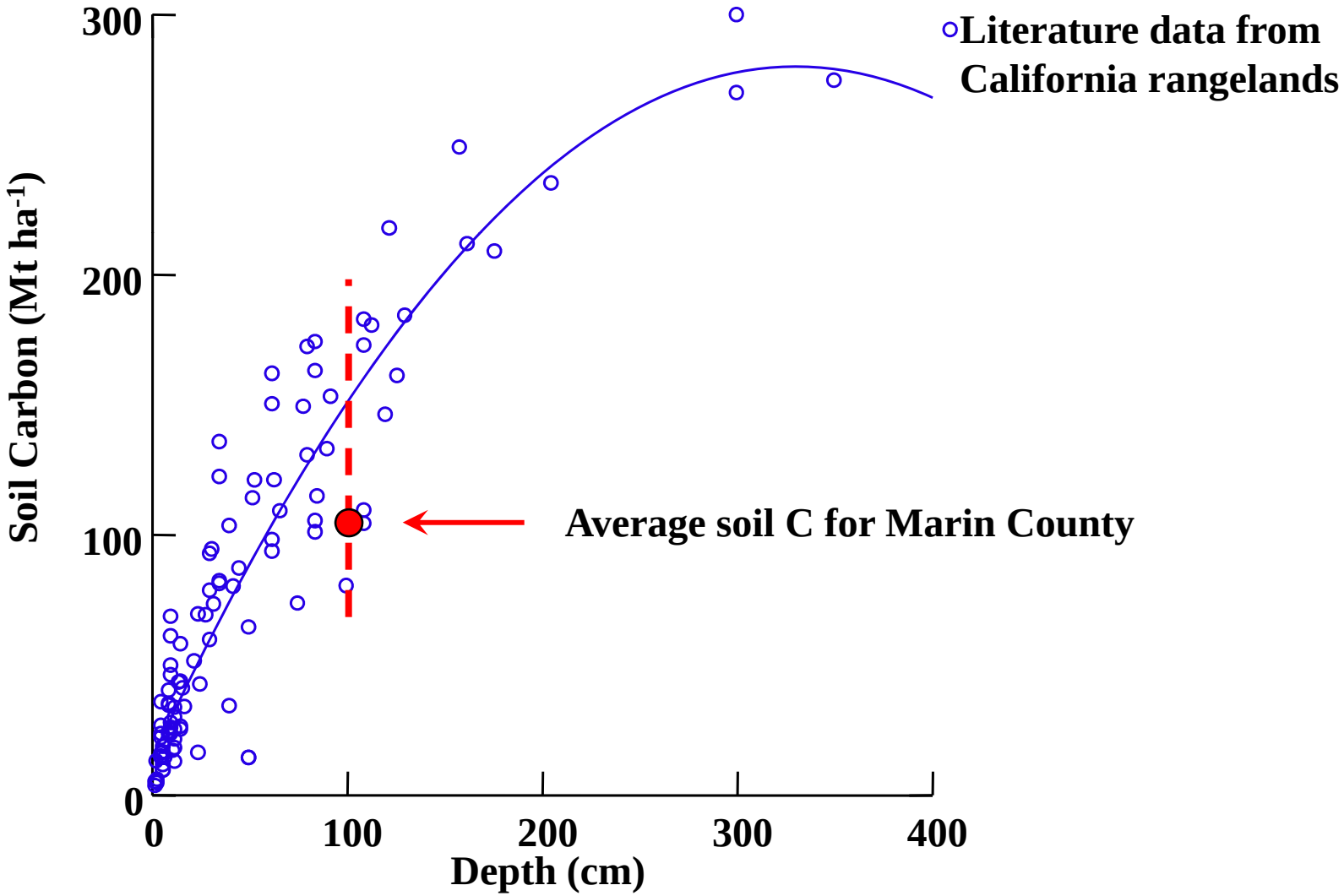
Mapprepared by Marin Agricultural Land Trust
February 2008

Sample locations approximate and should be field verified

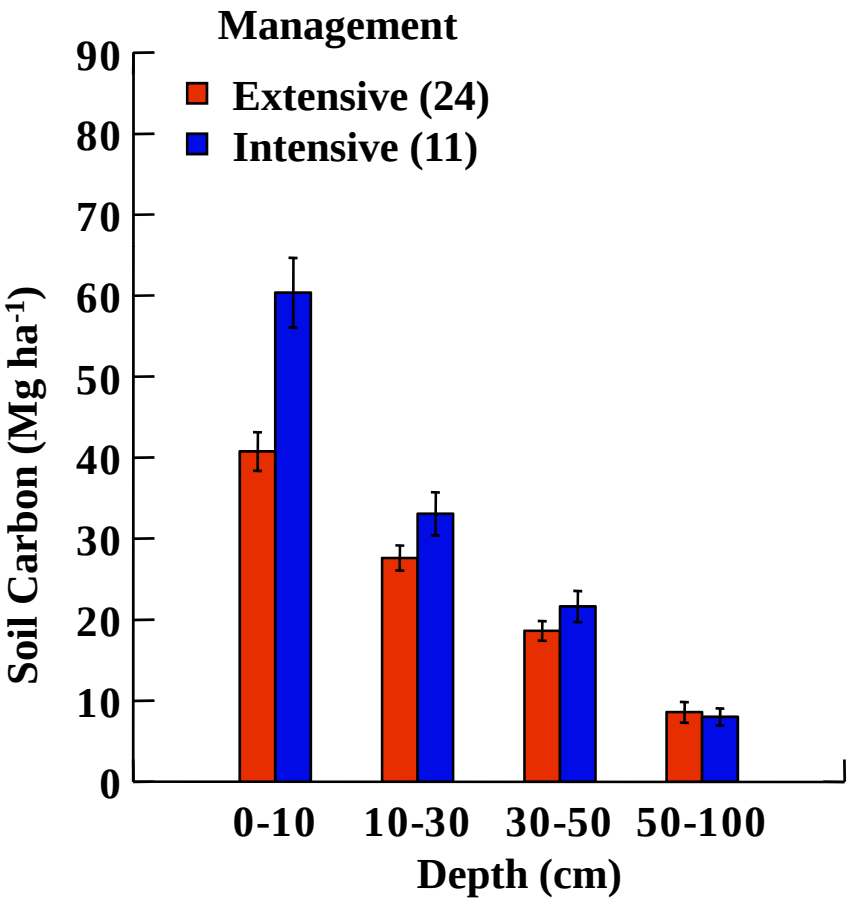
The regional analysis also showed a wide range in soil C pools

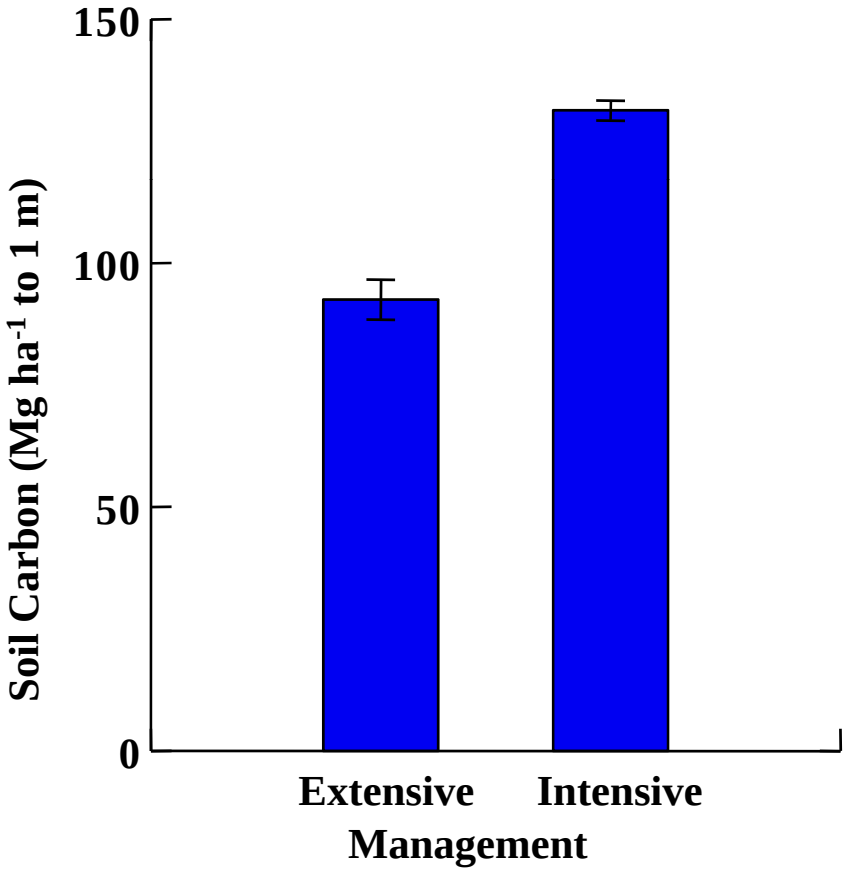


On average Marin soils appear to be in the low to mid range of California rangelands



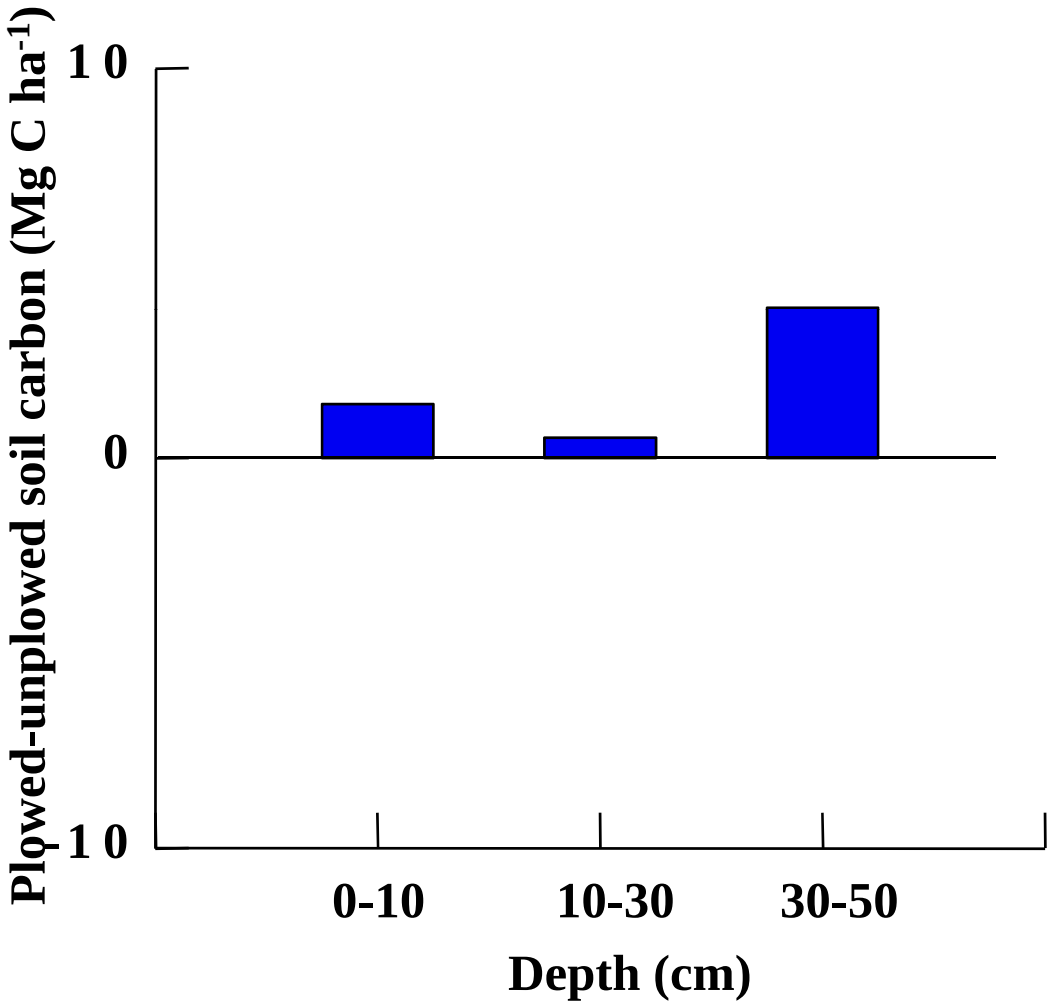
Organic amendments increased soil carbon by 40 Mt C ha^{-1} in the top meter of soil

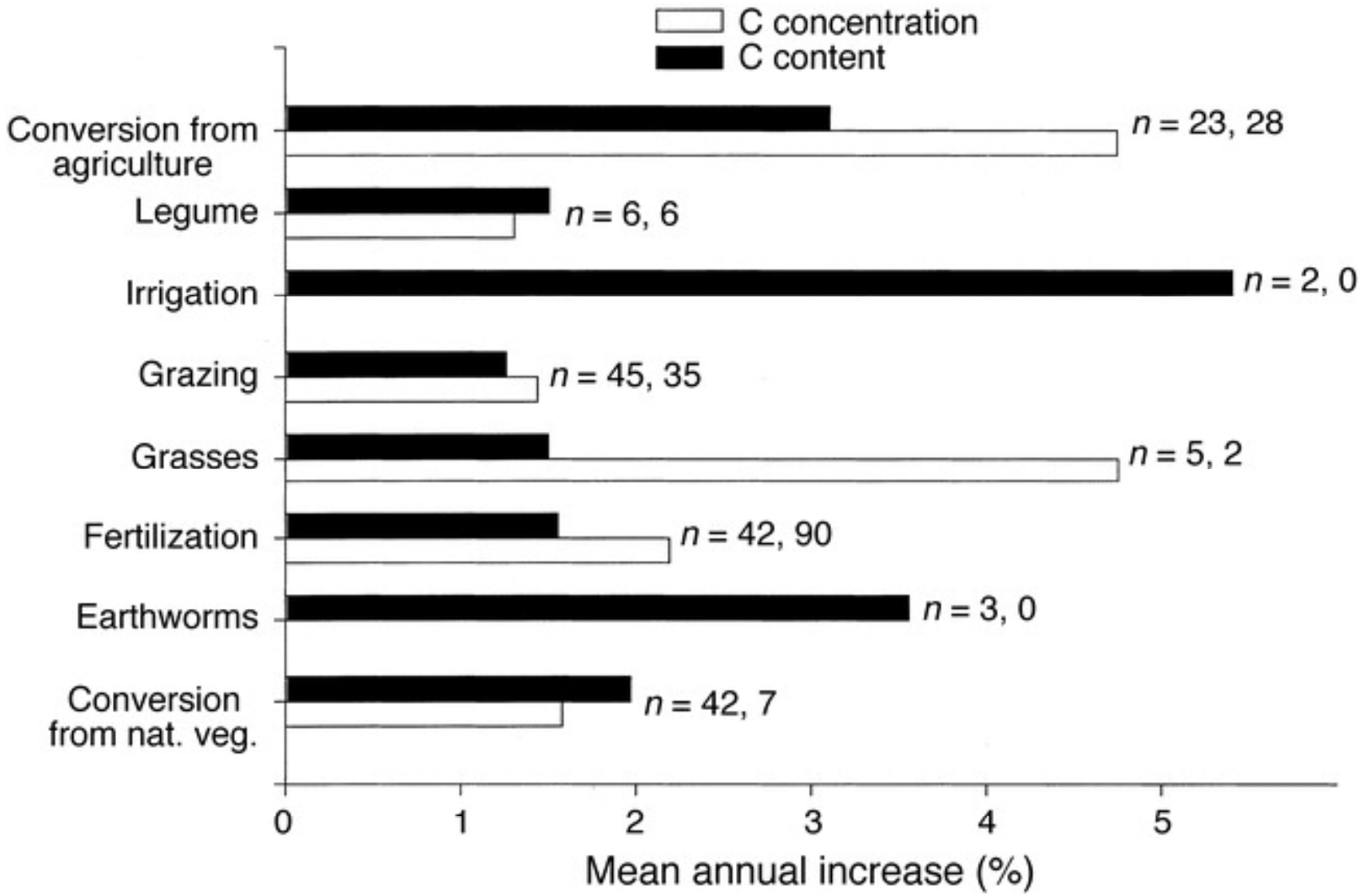




Subsoiling (also known as the Yeoman plow)

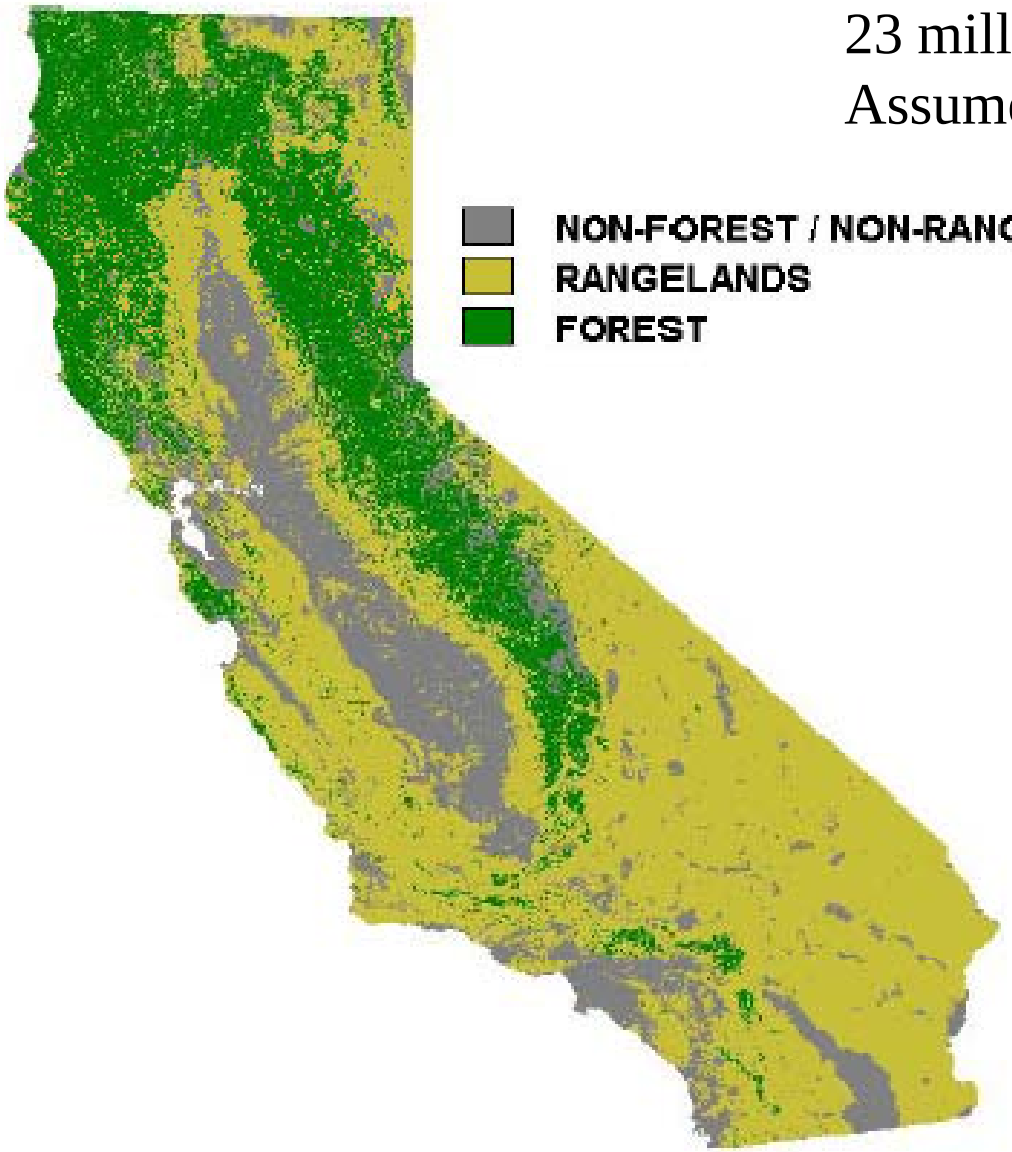
Subsoiling may also increase soil carbon pools





Conant et al. 2001)

California Grasslands



23 million hectares of rangeland statewide
Assume 50% available for C sequestration

At a rate of 1 Mg C ha^{-1} y^{-1}
= 42 MMT CO_2e/y

At a rate of 5 Mg C ha^{-1} y^{-1}
211 MMT CO_2e/y

- **Livestock ~ 14 MMT CO_2e/y**
- **Commercial/residential ~ 41 MMT CO_2e/y**
- **Transportation ~180 MMT CO_2e/yr**
- **Electricity ~109 MMT CO_2e/y**

Marin Carbon Project
Phase II

The Marin Carbon Project seeks to identify verifiable approaches to soil carbon sequestration in managed ecosystems.

➔ use range management science, biogeochemistry, soil science, plant ecology, and ecosystem ecology to determine the best approaches for long term carbon storage in soil.

➔ focus on the mechanisms responsible for carbon storage and loss, and test promising management approaches for increased plant productivity and long term carbon sequestration.

➔ implement most promising management approaches on a range of sites to optimize for carbon sequestration and land owner goals.

Approach

Determine the separate and combined effects of organic amendments and subsoiling on:

1. **Carbon pools and greenhouse gas fluxes**

2. **Carbon inputs via net primary productivity**

3. **Carbon sequestration mechanisms**

4. **Soil water dynamics**

5. **Soil stability**

Nicasio Field Site (WR-5)

Summary

Rangelands have considerable potential to sequester atmospheric CO_2

The co-benefits are large and the risks are relatively low

Organic amendments or woody plant addition are poetntial strategies to increase carbon sequestration.

Research needs include life cycle analyses, verification and protocol development, and optimization tools

Big Questions Remaining

1. **Life Cycle Analysis: what is the full greenhouse gas accounting of these management activities?**

2. **Grazing Management: can grazing management alone increase soil carbon storage?**

3. **Plant Community: What happens to it and can we encourage native perennial grasses through carbon farming?**

4. **Translating Science to Implementation and Policy: verification, protocols, additionality**


Thank you

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

Part II: Discussion

Notes compiled and synthesized by Kayje Booker, Roundtable GSR

Berkeley Faculty Roundtable on Environmental Services in Rangeland Production Systems

I. Issues and questions in response to Whendee's presentation:

- Consideration of these management actions on plant communities, etc. Can they really be considered low-risk?
    - John and Peggy (on whose ranch the Marin Carbon Project has taken place) replied that so far native grasses have been responding well to the yeoman's plow.
- Whendee's presentation showed a net carbon storage from land use change (based on IPCC slide). How is that happening?
    - Possibly younger ecosystem types, which take in carbon much more quickly than older types, especially young forest in the northern hemisphere.

II. Broader discussion of carbon storage in rangeland soils:

Most of the broader discussion centered on three interconnected issues with carbon storage in rangeland soils: uncertainty/lack of data, variability, and payment for carbon storage.

A. Uncertainty and Lack of Data:

- There is little carbon flux data on oak woodlands. A lot of data has been developed for forests but still missing for rangelands.
- There is a national network trying to put together soil carbon information to better develop these kinds of models.
- Could use a CA network to share data across the state. There may be data in the gray literature (or unpublished data) that could be useful if there was a place to share it.
- We will need uncertainty estimates for carbon fluxes and pools. This work has started for forests, but we'll need it for range as well.
- There is a national network trying to put together soil carbon information to better develop system-specific models.
- How long will carbon be stored? This matters for the landowner (if you are getting paid, it matters how long the carbon will be stored) and for policy makers who are searching for both near and long-term climate mitigation strategies.
    - Whendee and her team are going to look at this by following the carbon in soil and seeing how much of it attaches to components that are believed to be long-lasting in the soil and unlikely to release to the atmosphere. They are also using C-14 dating to investigate the residence time of carbon in CA soils.

B. Variability:

- Rangelands are known to be very heterogeneous. How generalizeable is a study in Marin to other places in the state?
- The term "rangelands" is too broad. We need system-specific models.
    - Whendee's work used the Century model, which is not based on vegetation type but on edaphic and climate inputs.
- Is addressing variability important, or can we develop models that will give us reasonably good ballpark figures for policies and protocols?

- Work by Joel Brown has indicated that range sites are so variable that you would need a very fine scale resolution to really know how much carbon is being stored (or emitted) and at what rate. This is likely to be so expensive as to overwhelm any financial gains from carbon storage.
- Whendee replied that this view is largely a myth and that you can get big enough changes to make it worthwhile. In addition, they are looking for mean differences to build models and protocols that would enable large scale projects without the need to do fine scale sampling. Monitoring would still be necessary, but not necessarily at such fine scale.
- Whendee and her team were told by CARB that you can't measure carbon in soils. We need to get rid of the myth that carbon storage schemes can't work underground. These things can be measured and monitored with enough certainty to put a price on it. As it becomes more popular, commercial labs will get involved in the testing, and the price should come down.
- There is also work being done on using remote sensing and LIDAR (Light Detection and Ranging) data for scaling up and monitoring.
- Practically, what is going on for each specific small-scale plot is not important if we have an idea of the aggregate carbon changes. If a landowner does X management activity, which we know on average delivers Y carbon savings, we can pay them for that even if we don't know that the carbon savings are coming from their land. As long as we get the overall carbon savings, it does not matter to whom it is attributable.

C. Payment for carbon storage and the need for co-benefits:

- People often look at the carbon price and assume that they will be receiving that amount for their activities, but we must remember that those are gross prices. The actual amount will be far less because you have interest, middlemen, and verification/monitoring costs that could eat up most of the profit. Also payment comes five years after the activity.
- Whendee says that she tells ranchers not to count on the carbon market to make money. You can get a nice little bonus from it, but by itself it won't sustain a ranch. That is why it is important to focus on activities with co-benefits that meet other goals for ranchers (such as increased production).
- These co-benefits may be the real drivers of changes in management activities, especially if they respond to regulatory pressure on issues like erosion. Landowners would be very interested in those kinds of activities and likely to adopt them even if carbon payments were small.

III. Potential Action Item:

- California climate Registry is putting out a call in two weeks for a paper on range soils. You can go to the website and sign up for updates: http://www.climateregistry.org/