"Soil Carbon Pools in California's Annual Grassland Ecosystems" (Silver, Ryals, Eviner 2010)

BACKGROUND: Soil Carbon (C) sequestration has been proposed as a way to help offset greenhouse gas emissions and reduce the atmospheric CO_2 (IPCC 2007). To understand soil carbon sequestration potential, we first examined patterns in existing soil C pools. Rangelands cover a high percentage of the global land surface and thus offer a large soil C sequestration opportunity[1]. Despite the well-recognized potential for rangelands to store C, there have been few regional surveys of soil C pools in rangeland ecosystems[2]. Regional-scale analyses that study patterns in climate, soil type, cover type, or management allow us to begin to estimate the relative sensitivity of soil C pools to the environment and management practices. To date, the majority of research has been conducted in perennial grassland systems (with four seasons) in the Midwestern Great Plains, which differ from the annual grasslands of California's Mediterranean climate.

GOALS: The goal of this literature review was to provide an estimate of soil C stocks and associated patterns in California rangelands and identify promising approaches for increased C sequestration in the future.

METHODOLOGY: This study was a formal assessment of peer-reviewed and published literature on soil C in California rangelands. Rangelands were broadly defined to include grasslands, oak savanna, oak woodland, coastal grassland complexes, and woody savannas. Most of the rangelands in this study were dominated by annual grasses, which tend to have shallower roots relative to perennial grasses. Soil C profiles from 48 data sets at 4 standardized depths were compared for soil type, location (latitude/longitude), temperature, precipitation, aboveground net primary productivity[3], clay content, grazing management, and vegetation cover type. Modeling was used to standardize soil sample depths across profiles.

FINDINGS: Results suggest that annual grasslands have similar soil C storage capacity as temperate perennial grasslands and offer an important resource for mitigation of greenhouse gas emissions and climate change.

Findings further suggest that regional management will play a key role in increasing soil C pools, as:

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- Soil carbon pools were not correlated with temperature or precipitation at a regional scale
- A weak positive correlation was found for soils containing higher clay content below the top four inches[4]
- The presence of a woody component in rangelands significantly increased soil C pools
- Soil C content peaked at intermediate levels of annual net primary productivity
- Grazed sites had slightly more soil C at all modeled depths than ungrazed ones, but the differences were small and not statistically significant at this level of resolution
- Soil C pools varied significantly at shallower depths across all variables, but were more predictable at depth

HOW CA COMPARES: Soil C pools in CA rangelands were found to be slightly larger than average US values for the top 3 feet. Values in CA were:

- Slightly lower than perennial grasslands in Texas (**40.5 tons C/ac**)
- Similar to Great Plains (range from **4-36 tons C/ac**) and correlated with climate differences across region

A NOTE ON GRAZING: Grazing can impact soil C pools by affecting C inputs through total plant growth, root to shoot allocation, and erosion. Reviews of perennial grasslands have found that improved grazing practices significantly increased rates of soil C sequestration. In this review, grazing appeared to have no statistically significant impact on soil C pools in California rangelands. However, this review was not designed to capture differences in grazing management practices, which likely varied among the studied areas with regard to history, duration, and intensity. It is critical to take context-specific interactions into consideration for effective ecosystem management.

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[1] Rangeland ecosystems cover approximately one-third of the land area in the United States and half of the land area of California.

[2] Bronson et al. 2004; Derner and Schuman 2007; Smith et al. 2008

[3] Net primary productivity is a technical term used to describe the overall biomass production of plants in an ecosystem.

[4] Finely textured soils such as those with clay generally have a greater reactive surface area and therefore are able to better store more C than coarsely textured, or sandy soils.