Plant Species Composition, Soil Biology, and Carbon Storage in California Grasslands

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How important are shoot and root inputs for soil C accumulation during grassland restoration?

Objective:

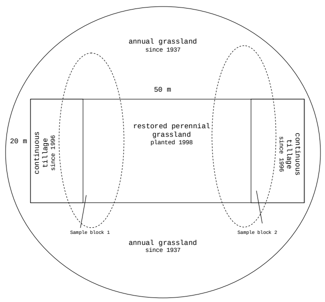
Examine biological and soil properties during peak spring activity in grassland profiles (April, 2002).

Treatments:

- Restored native perennial grassland (4 yrs later after 2 yrs of tillage to decrease seed of non-native annuals)
- Non-native annual grassland (75 yrs after last tillage)
- Tilled, bare soil (6 yrs after 69 yrs of annual grassland)

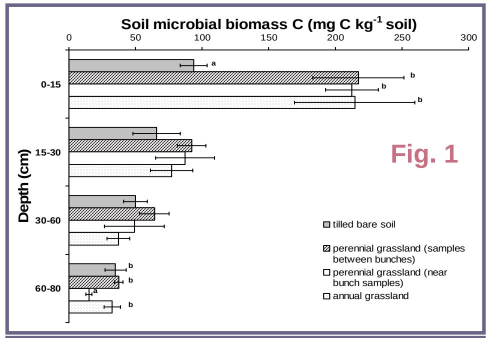
Site:

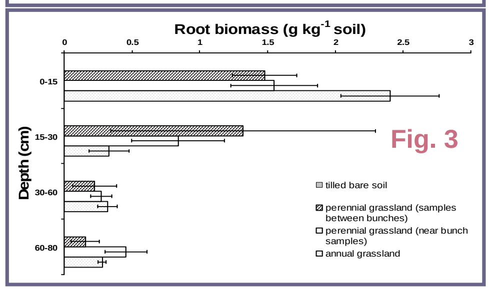
- UC Hastings Reserve, Monterey County, CA
- Sheridan coarse sandy loam

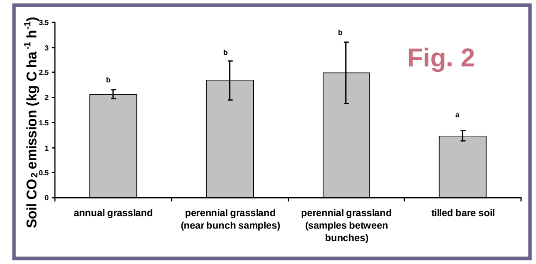


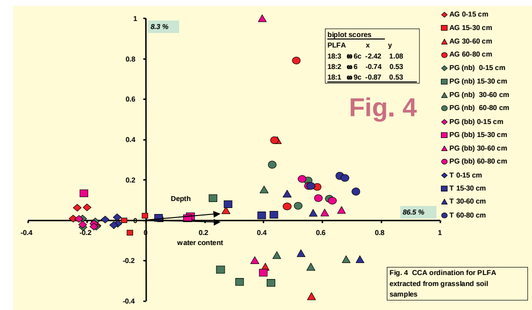
Results:

- 25% decrease in total C in surface (0-15 cm) of tilled treatment (data not shown).
- Mic. biomass C decreased in surface of tilled treatment, but no changes at lower depths (Fig. 1). Same trend for soil respiration (data not shown).
- Higher CO_2 efflux from the soil surface in grassland than tilled plots (Fig. 2). CO_2 in soil gas also higher, probably due to root respiration (data not shown).
- More roots at depth in restored perennial grassland (Fig. 3).
- Phospholipids (e.g. 18:3 ω6c) and ergosterol levels indicate more fungi in surface of grasslands than tilled soil, but similar microbial communities at depth (Fig. 4).









How do fates of added litter respond to plant species composition?

Objective:

Track the fates and effects of added C_4 plant litter (*Bouteloua gracilis*) in field microcosms with a native annual legume (*Lupinus bicolor*) and/or added phosphorus (P).

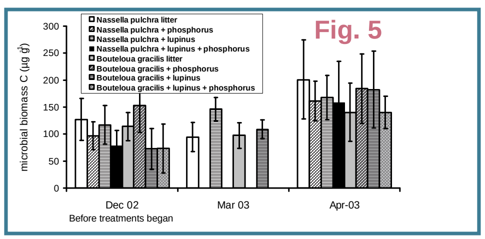
Treatments:

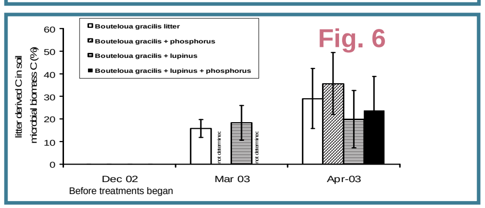
- C_3 litter vs. C_4 litter from *Bouteloua gracilis*. More C_4 than C_3 litter to test if added litter aids with restoration.
- ± planted lupins
- ± added P (30 g m^{-2})

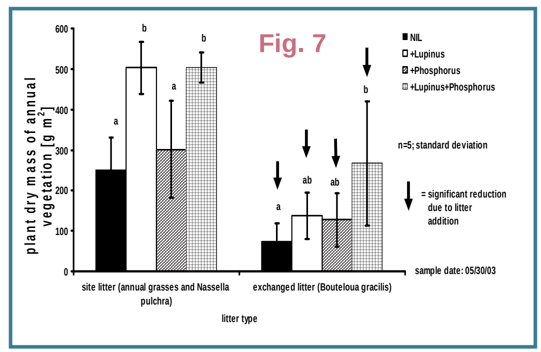
Restored perennial grassland. Each cylinder contains a native perennial grass (*Nassella pulchra*). *Bouteloua gracilis* (C_4) litter is shown. More C_4 than C_3 litter present

Preliminary results:

- Mic. biomass C not affected by litter or nutrient treatment after 5 months (Fig. 5).
- High uptake of C_4 litter-derived C by microbial biomass, based on ^{13}C enrichment (Fig. 6).
- Higher plant aboveground biomass in lupin treatments (Fig. 7). No P effect. C_4 litter decreased plant growth.
- Lupin effect on soil C may occur next year after its litter degrades.







Methods:

- Soil microbial biomass C (MBC) (Vance et al. 1987; Soil Biol. Biochem. 19, 703-707)
- ^{13}C in MBC (adapted from Potthoff et al. 2003)
- PFLA (Bossio & Scow 1995; App. Env. Microbiol. 61, 4043-4050); Canonical Correspondence Analysis (CCA) using CANOCO program
- Ergosterol (Djajakirana et al. 1996; Biol. Fertil. Soils 22, 299-304)
- Soil respiration (CO_2 production) in sealed containers; CO_2 in soil gas using steel probes with screen at designated depths; CO_2 emissions in closed chambers for 30 min
- Aboveground biomass estimated from cover/biomass relationship outside the cylinders

Conclusion: Changes in root inputs during restoration have minor effects on soil C in deep zones. At lower depths, microbes may rely on more recalcitrant C sources. Surface litter stimulates microbial C uptake and soil C retention. Planting legumes may enhance total C sequestration in restored grasslands.