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 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 Sheridan coarse sandy loam)

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 CO2 efflux from the soil surface in grassland than tilled plots (Fig. 2). CO2 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. 18:3ω6c), ergosterol, and phosphorus 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 C4 plant litter (Bouteloua gracilis) in field microcosms with a native annual legume (Lupinus bicolor) and/or added phosphorus (P).

Treatments:
- C4 litter vs. C3 litter from Bouteloua gracilis. More C4 than C3 litter present.
- More C3 than C4 litter present.
- ± planted lupins
- ± added P (30 g m^-2)

Preliminary results:
- Mic. biomass C not affected by litter or nutrient treatment after 5 months (Fig. 5).
- High uptake of C4 litter-derived C by microbial biomass, based on 13C enrichment (Fig. 6).
- Higher plant aboveground biomass in lupin treatments (Fig. 7). No P effect. C4 litter decreased plant growth.
- Lupin effect on soil C may occur next year after its litter degrades.

Methods:
- Soil microbial biomass C (MBC) (Ryan et al. 1987; Soil Sci. Beechem. 19, 703-707)
- 13C in MBC (adapted from Potthoff et al. 2003)
- PPLA (Rosen & Xooch 1995; Appl. Environ. Microbiol. 61: 4043-4050); Canonical Correspondence Analysis (CCA) using CANOCO program
- Soil respiration (CO2 production) in sealed containers; CO2 in soil gas using stainless steel probes with wicks at designated depths; CO2 emissions in closed chambers for 30 min
- Aboveground biomass estimated from cover/aboveground 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.