

EBIS Microbial Carbon Cycling rates and substrates

Margaret Torn¹, Jessica Westbrook¹, Deb Williard¹, Dev Joslin²

¹Lawrence Berkeley National Laboratory, ²Belowground Forest Research



**Supported by U.S. Department of Energy
Enriched Background Isotope Study**



Research Questions

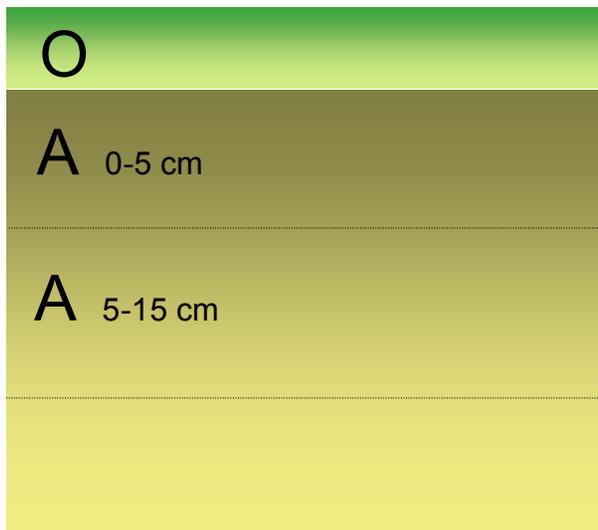
**Are there differences in contribution to SOM
from leaf vs. root inputs?**

**What are the substrates for microbial biomass and
heterotrophic respiration?**

**What is the isotopic signature of heterotrophic
respiration?**

Method: Chloroform Fumigation - Extraction

Sampling for ^{14}C -CFE



3 sub samples per plot

Walker Branch and TVA

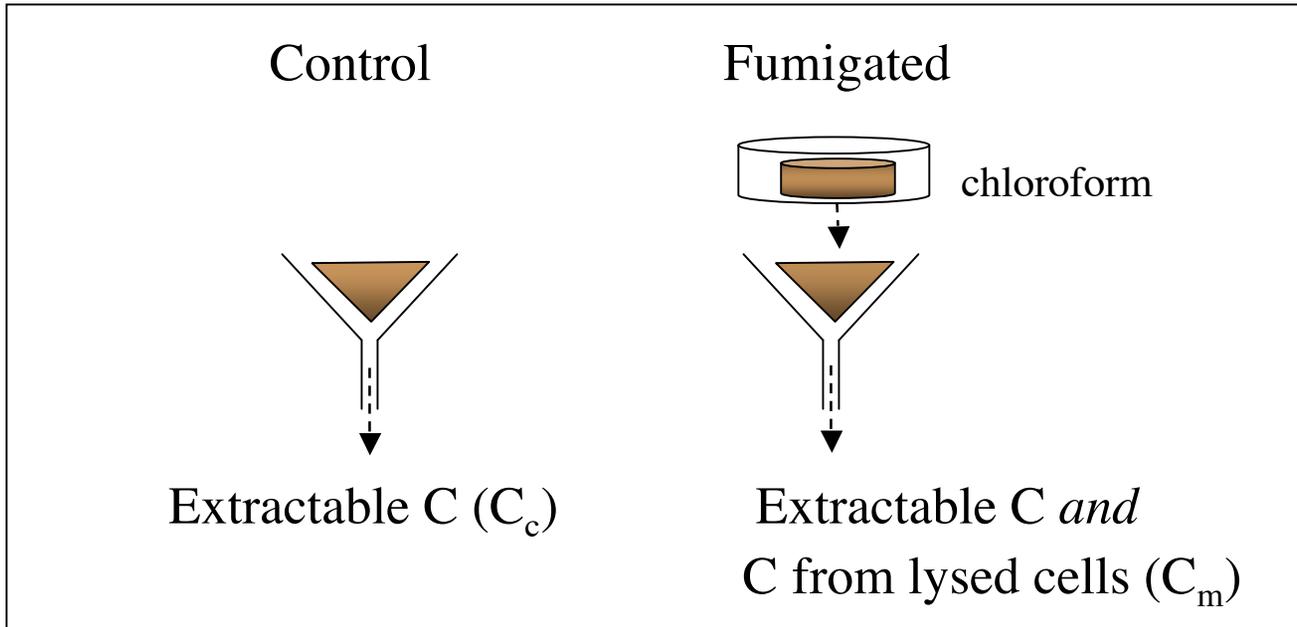
Spring 2002, 2003, 2004

Summer 2002, 2003, 2004

Extra sampling Spring 2004:

WB and TVA O Horizon

Haw Ridge and Pine Ridge 0-5, 5-15



$$\text{Microbial C} = C_F - C_c$$

$$C_F \Delta_F = C_m \Delta_m + C_c \Delta_c$$

$$\Delta_m = \frac{C_F \Delta_F - C_c \Delta_c}{C_F - C_c}$$

Site Nomenclature

Walker Branch Background Litter = Control

Walker Branch Enriched Litter = Litter

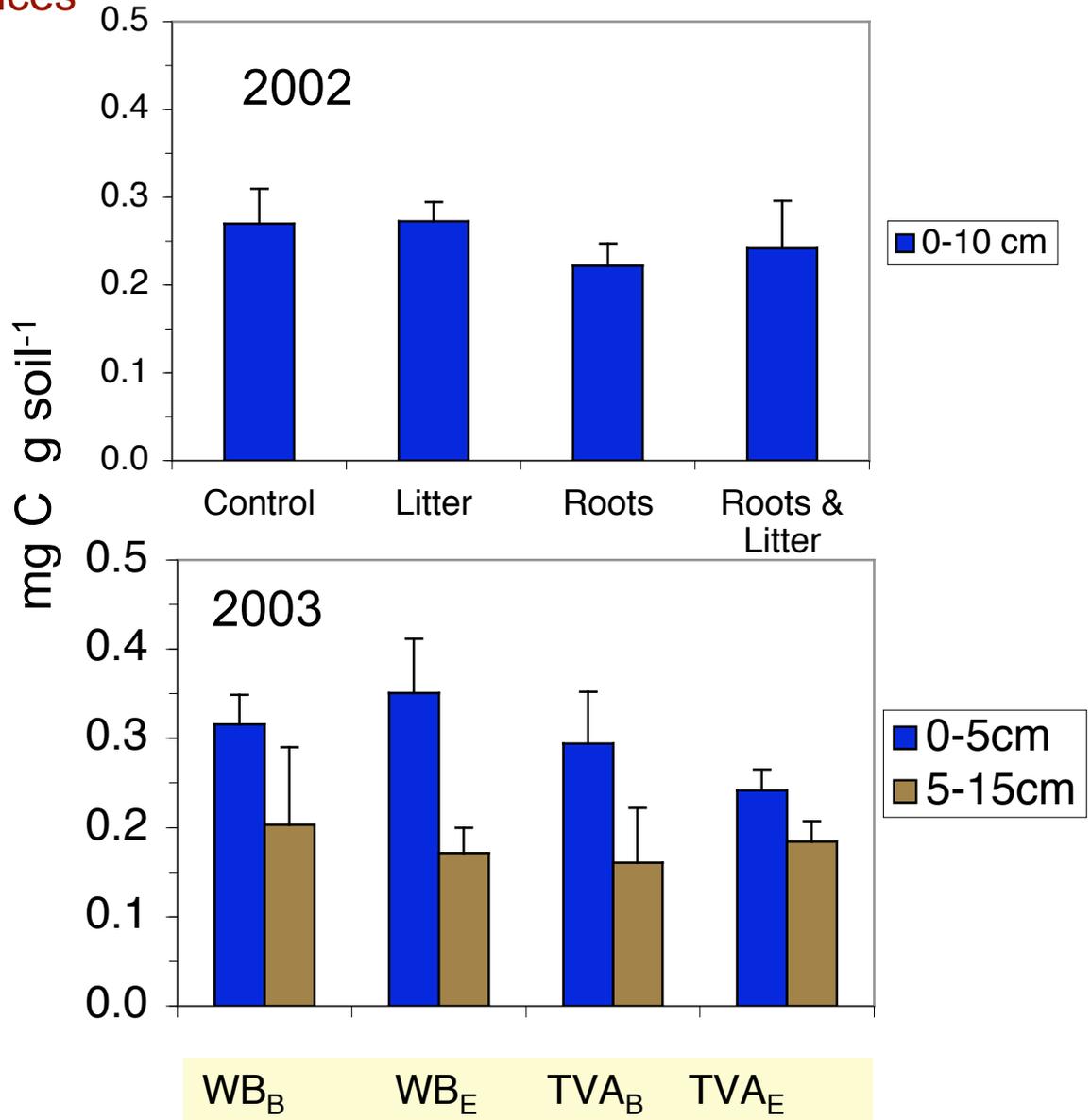
TVA Background Litter = Roots

TVA Enriched Litter = Roots & litter

Chloroform-Extractable C

No site or interannual differences
 0-5 cm > 5-15 cm

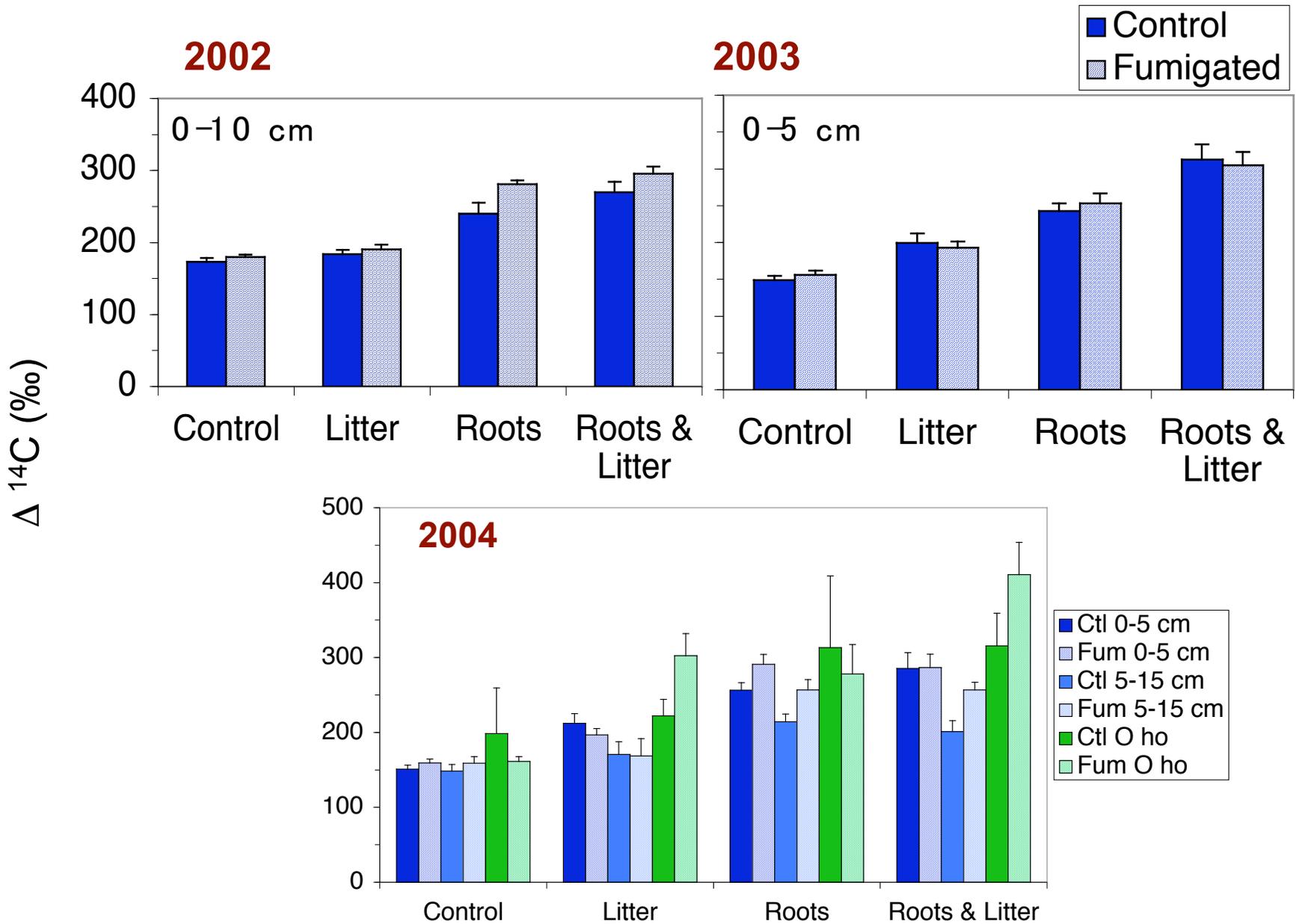
$n = 4 \pm se$



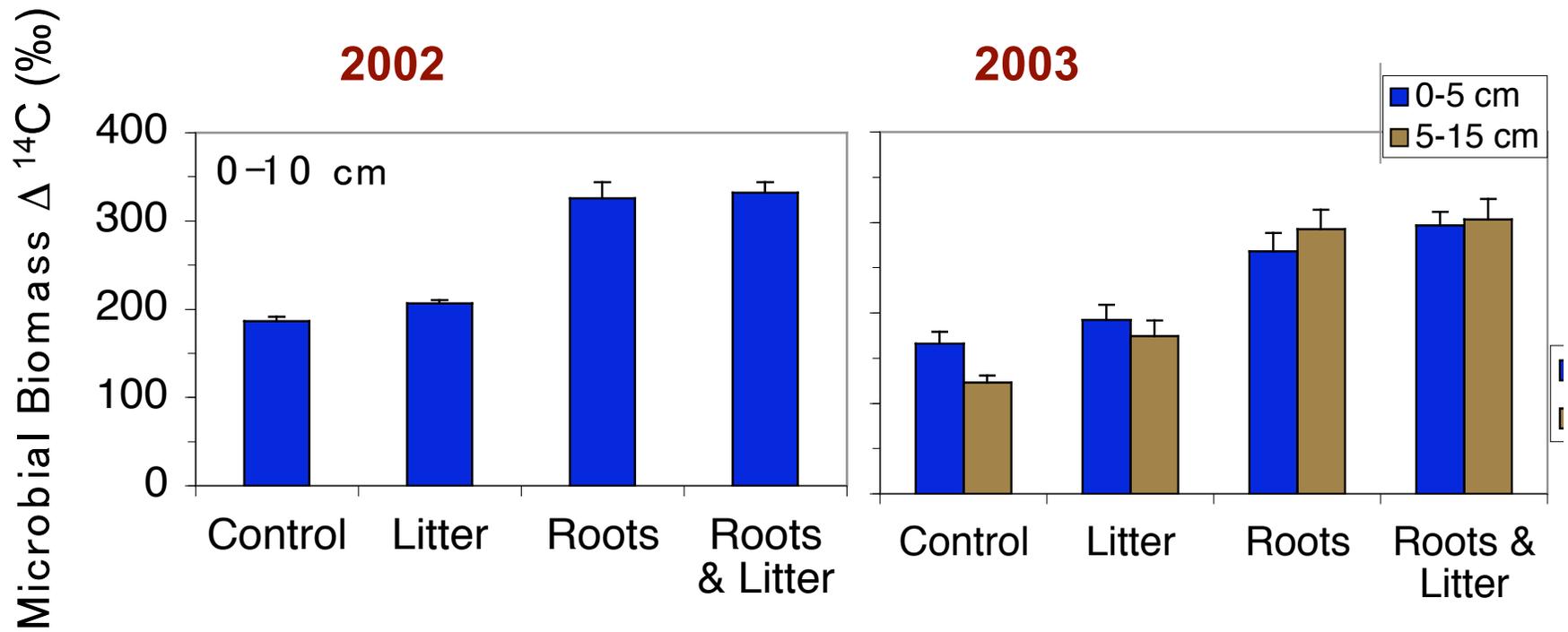
Soil Moisture
 ~ 25%

2003: WB >
 TVA

Extractable 14C: controls and fumigated



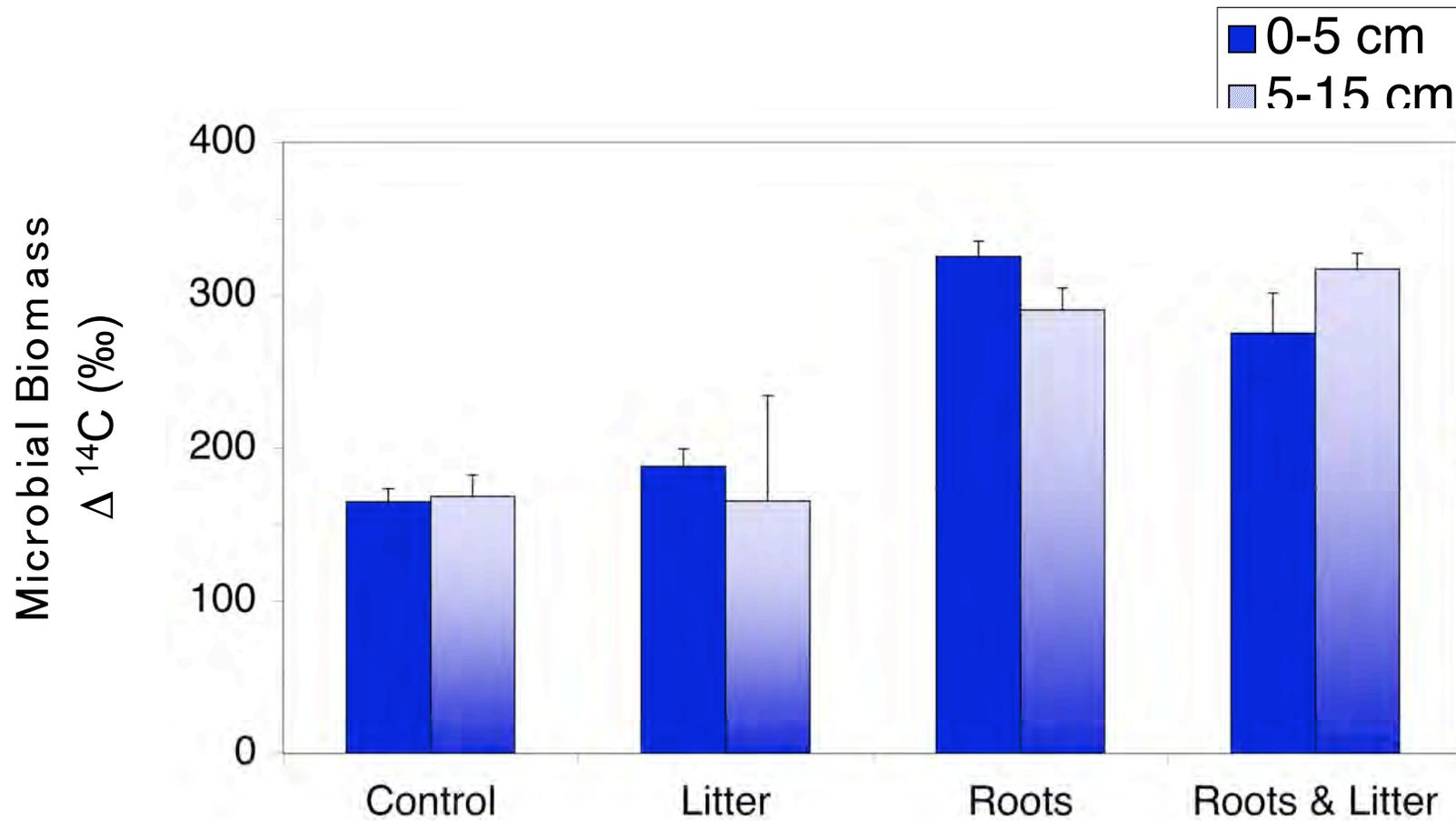
2002–2003 Microbial ^{14}C



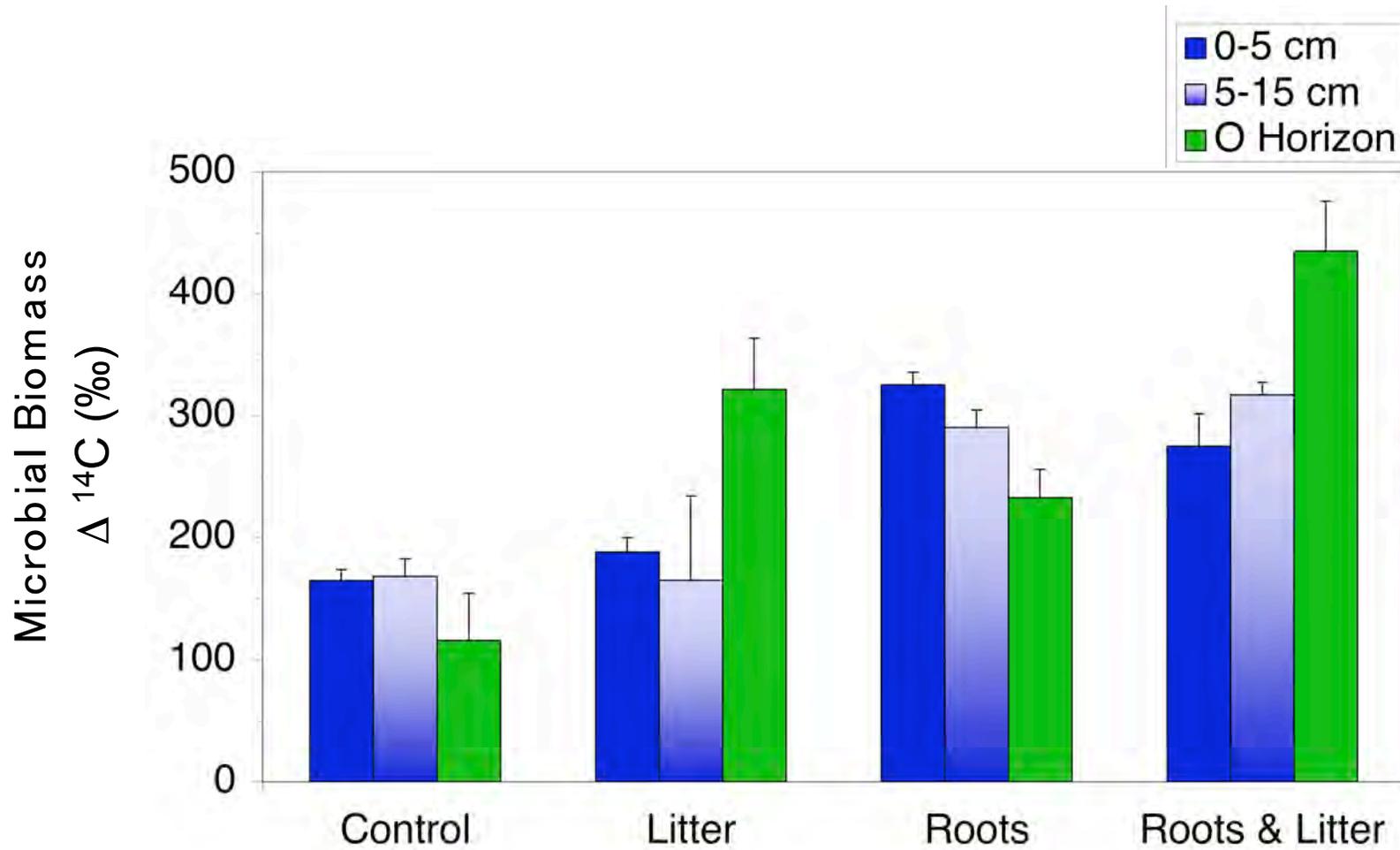
Potential explanations for lack of enrichment from Litter Additions

1. Leaf litter is decomposed and mineralized in O horizon and doesn't contribute much to A horizon SOM.
2. Time lag of inputs to A horizon. Root input on west side started several years before litter treatment. Takes time for litter C to migrate to A horizon
If so, Litter plot 14C will continue to go up.
Test: measure multiple years
3. Time lag in microbial biomass response.
If so, microbial biomass in O horizon will not be enriched.
Test: measure O horizon.
4. Most of biomass is ecto fungi with root signature.
Estimate 30% ECMF.
Test: will determine bacteria:fungi ratio in 2005

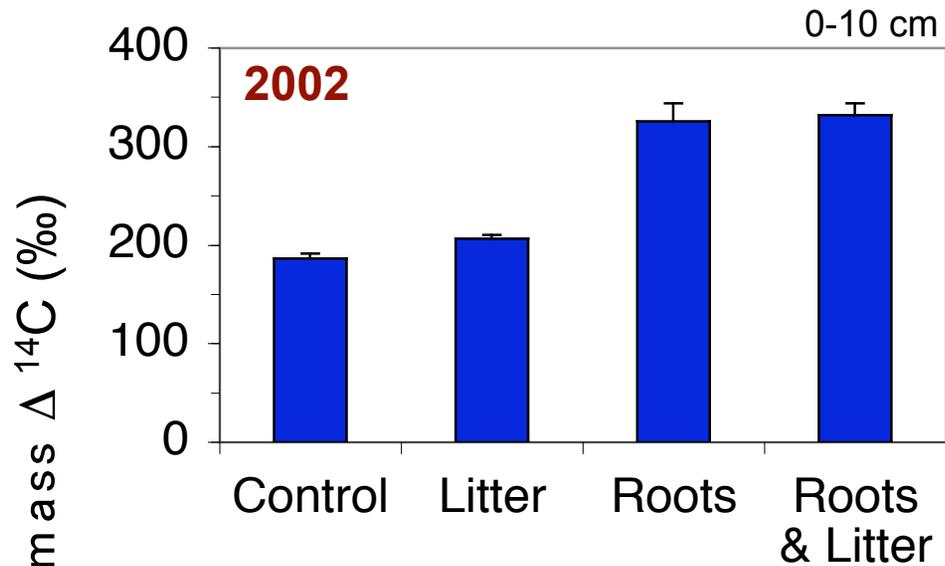
Spring 2004 Microbial Biomass ^{14}C



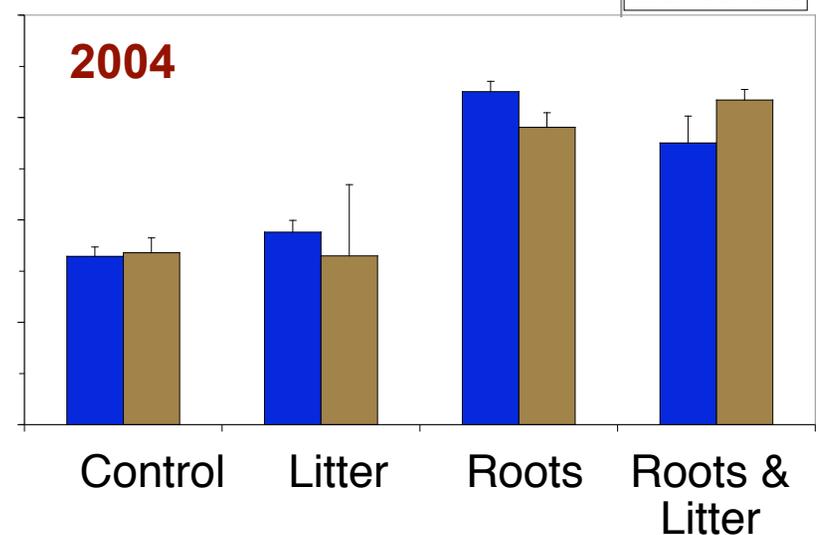
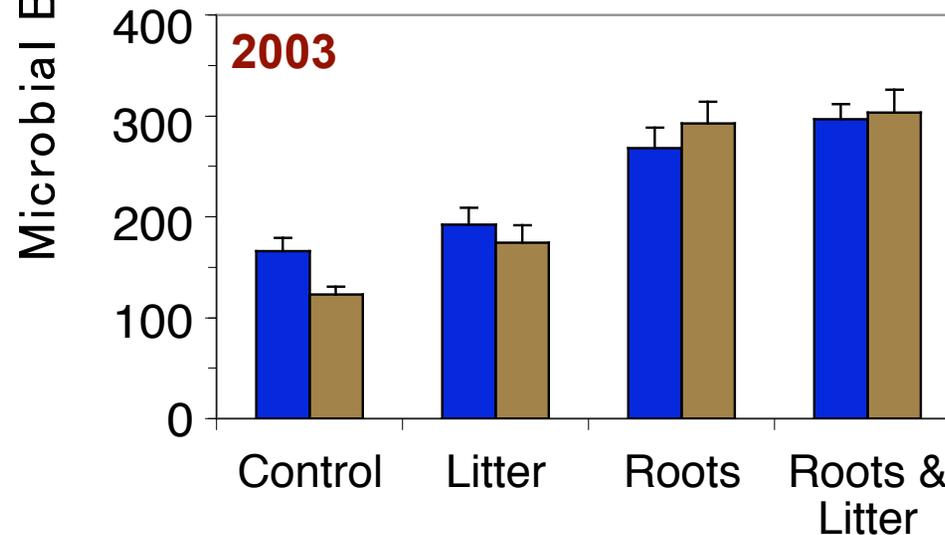
Spring 2004 Microbial Biomass ^{14}C with O Horizon



Microbial ^{14}C : Spring 2002-2004



Enrichment decreased slightly after 2002. No change in pattern or roots and litter inputs.



Summary: Microbial Biomass

A Horizon Microbial Biomass is more ^{14}C -enriched in treatments with enriched roots. Very small effect of litter.

O Horizon Microbial Biomass is more ^{14}C -enriched in treatments with enriched litter and there is a root x litter interaction (i.e., both roots and litter contribute to enrichment)

Heterotrophic signature = ~ 180‰ East
= ~ 320‰ West

Between years: Small initial decrease in microbial biomass ^{14}C

Same patterns in Extractable C.

.

Conclusions: Microbial Biomass

- Nearly all soil OM in A horizon derives from root inputs.
- Leaf litter decomposes in O horizon and is lost as CO₂ or DOC leaching deep in profile. Cycling is largely independent of A horizon.
- Microbes in O horizon utilize both leaf and root substrates.
- There appears to be a lot of the burp remaining in heterotrophic respiration and C cycling (could also be explained by abundant, dormant bacteria).

Future Work: Microbial Biomass

- Complete analysis of Haw Ridge and Pine Ridge data (Spr 2004)
- Complete analysis of WB & TVA July 2002-2004
- 2005 sampling: O ho and A ho (more sophisticated analyses?)
- 2005 sampling: bacterial:fungal ratio (elaine ingram?)
- 2005 sampling: water extractable C?

EBIS Ectomycorrhizal Fungi: Are they decomposers in this warm temperate forest?

Kathleen Treseder², Margaret Torn¹, Carrie Masiello³

¹Lawrence Berkeley National Laboratory

²University of California, Irvine

³Rice University



- Supported by U.S. Department of Energy
- Enriched Background Isotope Study



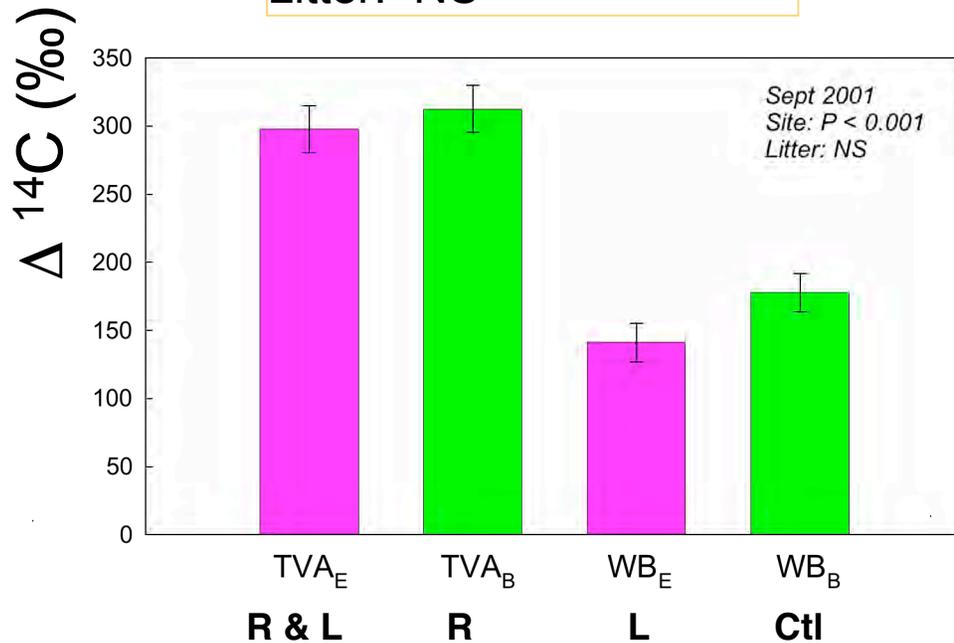
Ectomycorrhizal root tips



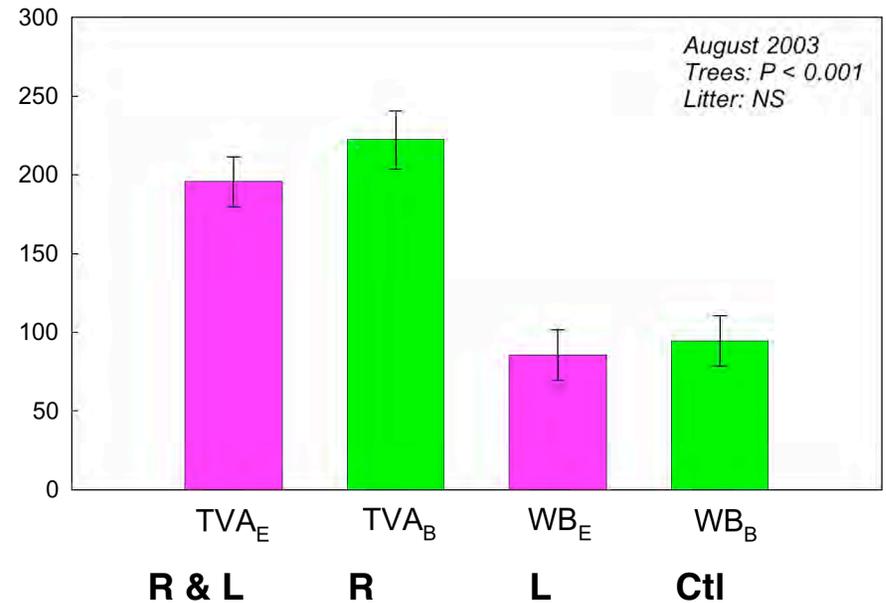
Collected September 2001 and August 2003
Walker Branch and TVA

ECM fungi didn't incorporate soil C... even through 2 winters

Sept 2001
Trees: $P < 0.001$
Litter: NS



August 2003
Trees: $P < 0.001$
Litter: NS



Summary: ECM Fungi

- **No switch between mycorrhizal and saprotrophic functions, or decomposing only recent root material.** (decline in ^{14}C is faster than for microbial biomass)
- **Implications for regulation of decomposition by ectomycorrhizal fungi.**
- **Kathleen Treseder is aiming to have draft ms by Feb 15, for projected March 1 submission.**

Acknowledgments

EBIS working group
especially

- Paul J. Hanson
- J. Devereux Joslin
- Chris Swanston
- Tom Guilderson
- Michael Kashgarian

Department of Energy

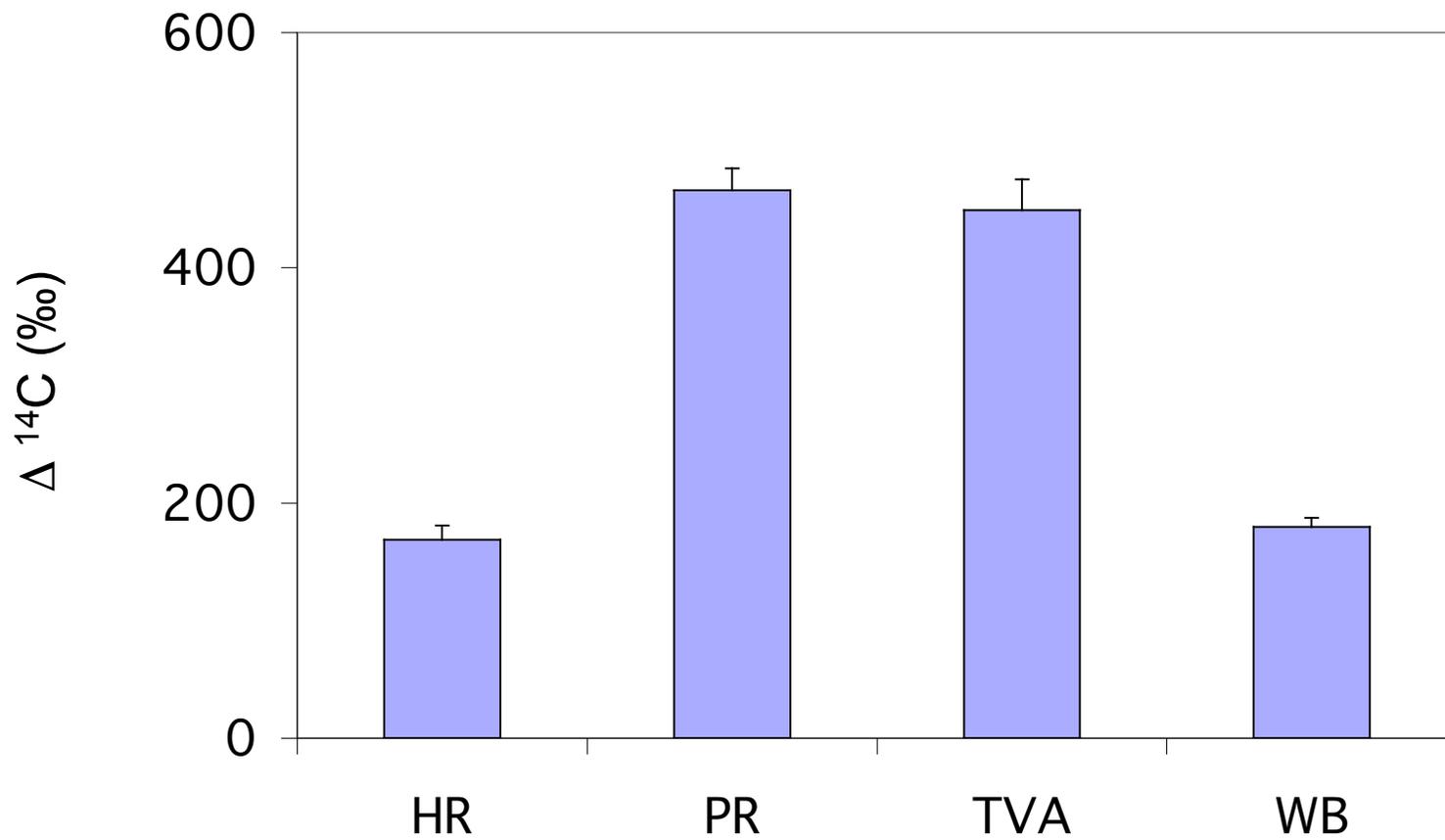
Lawrence Livermore National Laboratory

Lawrence Berkeley National Laboratory

And

Alison Cross, China Hanson, Tara Macomber, Malu, Sue...

Root Screens ^{14}C
In Oct 03 -- Out Sep 04



Root Cores ^{14}C

Harvest Jan 2004

