

# **Enriched Background Isotope Study (EBIS)**

**A litter reciprocal transplant study to understand sources,  
transport, and fate of carbon in soils**

**Oak Ridge National Laboratory**

**Lawrence Livermore National Laboratory-CAMS**

**Argonne National Laboratory**

**Lawrence Berkeley National Laboratory**

**University of California - Irvine**

**University of California - Santa Barbara**

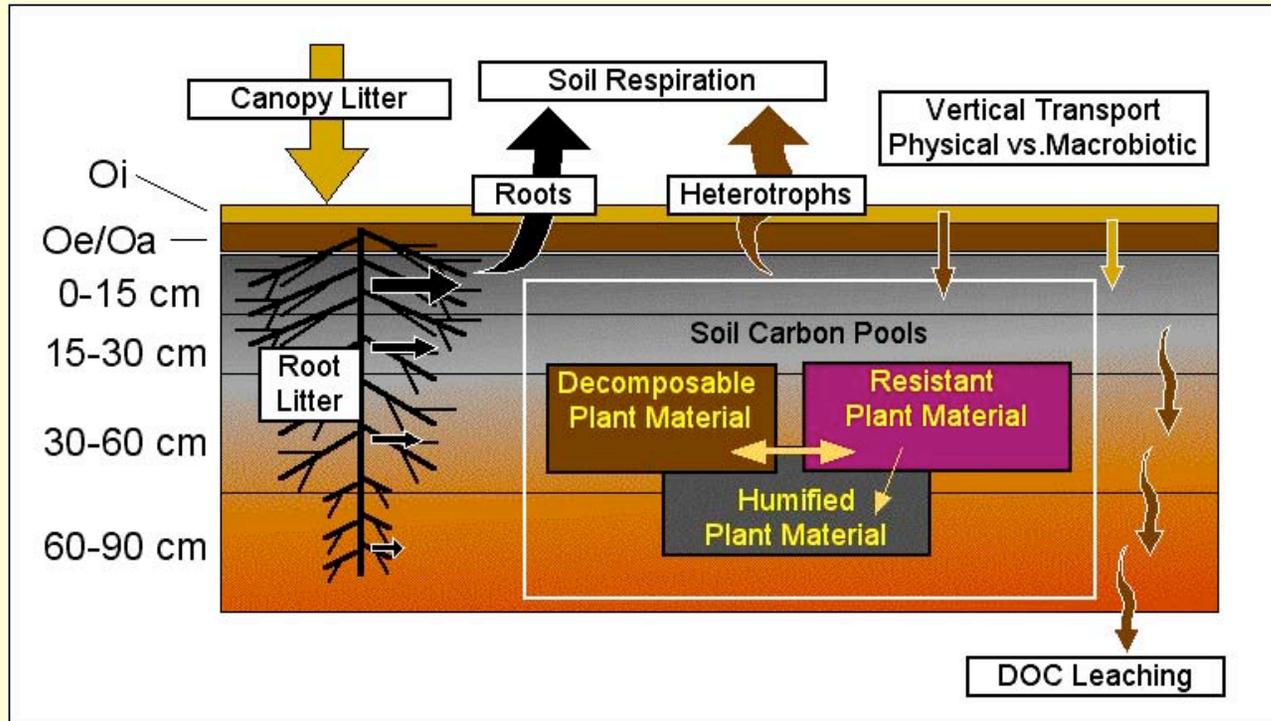
**Belowground Forest Research**

**USDA-Forest Service, Southern Research Station**



Sponsor: U.S. Department of Energy, Office of Science, Biological and Environmental Research (BER), Terrestrial Carbon Processes Program (TCP).

# Experimental Goals

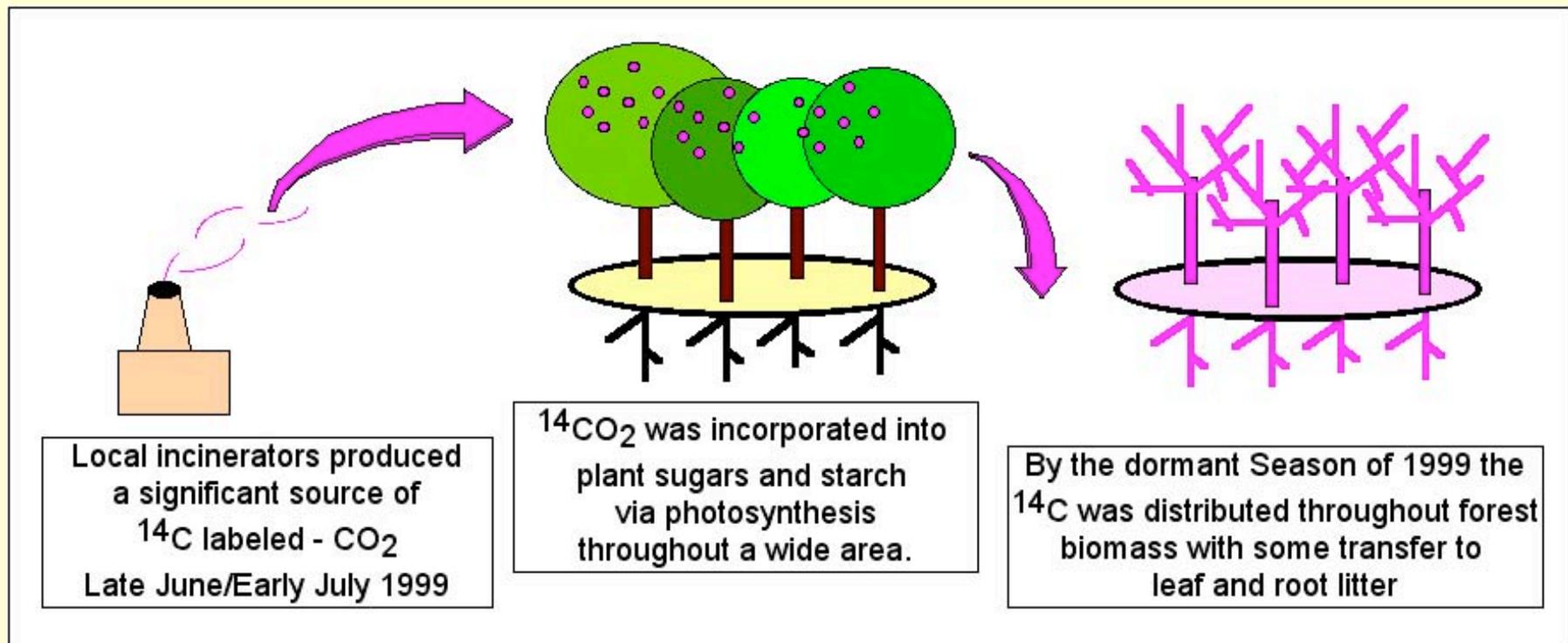


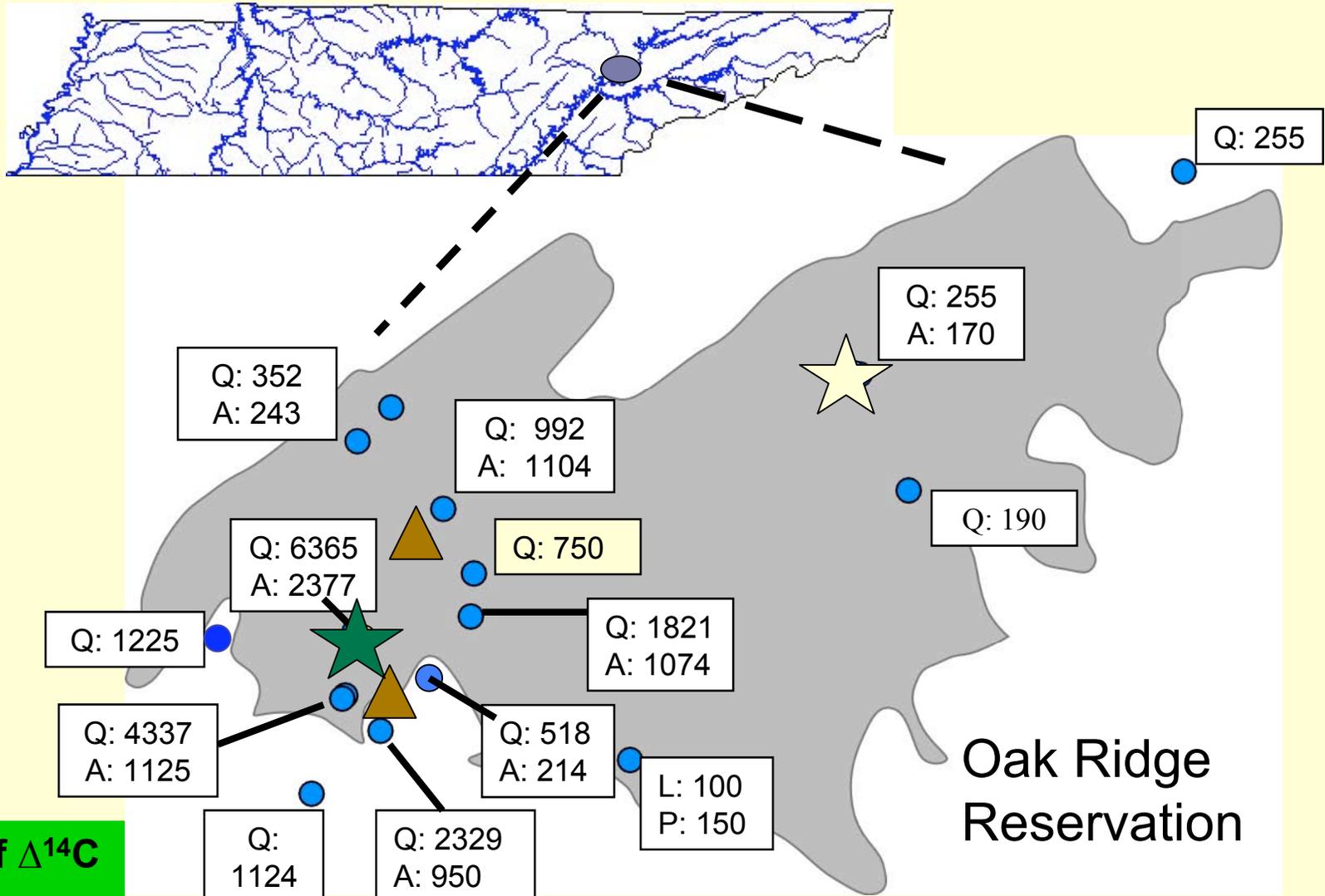
- Partitioning of soil respiration between autotrophic and heterotrophic sources
- Distinguishing between above- and belowground C sources
- Quantifying pathways and rates of transfer from carbon sources to soil carbon sinks
- Quantifying the role of dissolved organic carbon in vertical transport
- Evaluating the longevity and turnover time of fine roots

# EBIS and the NACP

- The EBIS project seeks to improve our understanding of and ability to model the fate and accumulation of carbon within organic and mineral soils of deciduous oak-dominated forests that comprise 46 to 60 million hectares of North America east of the Mississippi River.
- EBIS project goals are related to program elements 3a and 4 of the implementation plan for the NACP dealing with terrestrial measurements and modeling of the land biosphere and biosphere-atmosphere interactions.
- The  $^{14}\text{C}$ -tracer-enhanced studies of the EBIS project provide a uniquely robust means to quantify rates of soil carbon inputs, turnover and accumulation for both short (years) and long (decades to century) timescales within a time span of 3-10 years.
- Such data provide the means for constraining and enhancing bottom-up models of soil carbon accumulation that represents the long-term storage pool of carbon within terrestrial ecosystems.

# The 1999 $^{14}\text{C}$ Event





**Green-leaf  $\Delta^{14}\text{C}$**

A = *Acer*

Q = *Quercus*

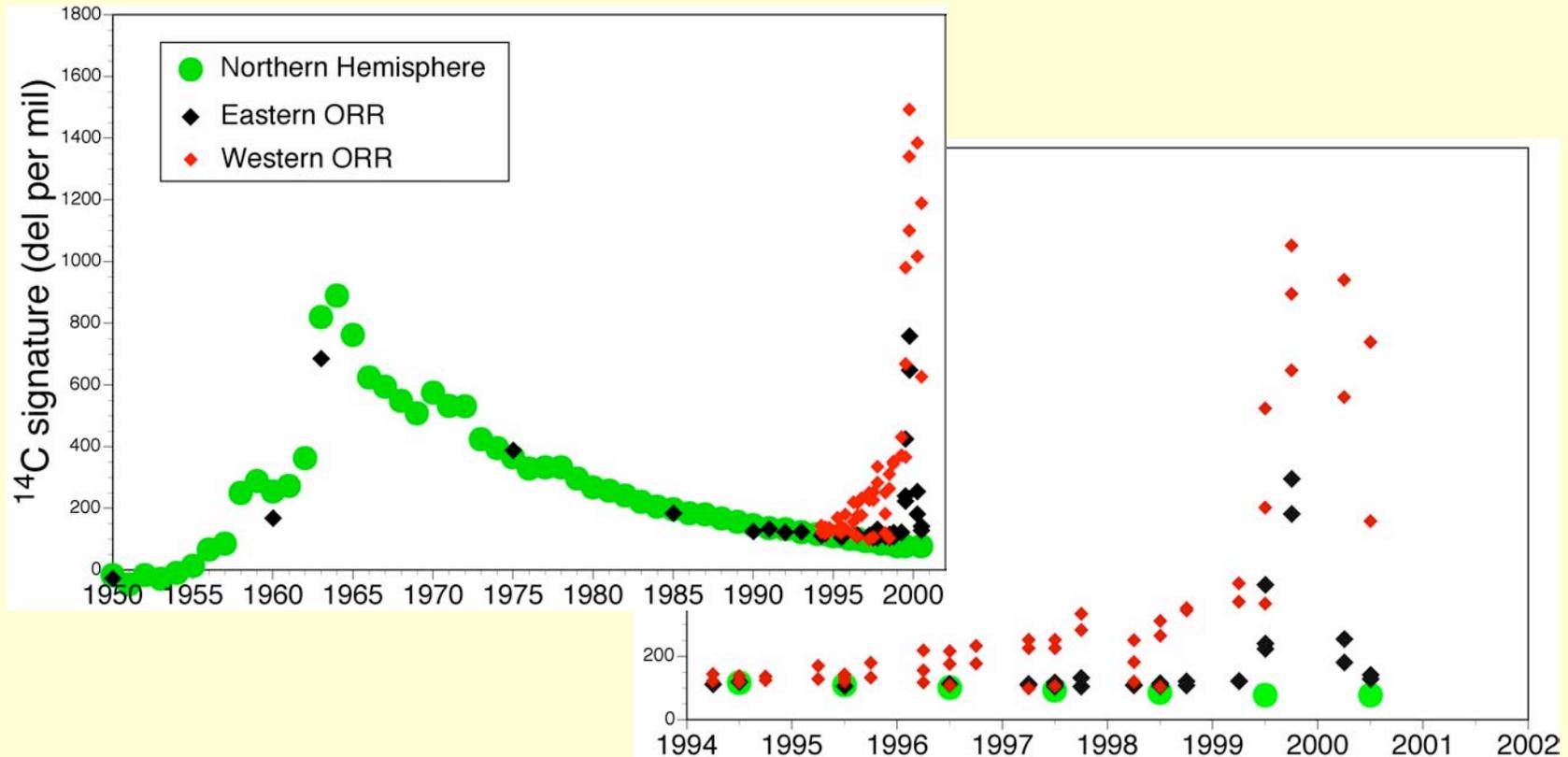
L = *Liquidambar*

P = *Platanus*

▲ Hazardous waste incinerators

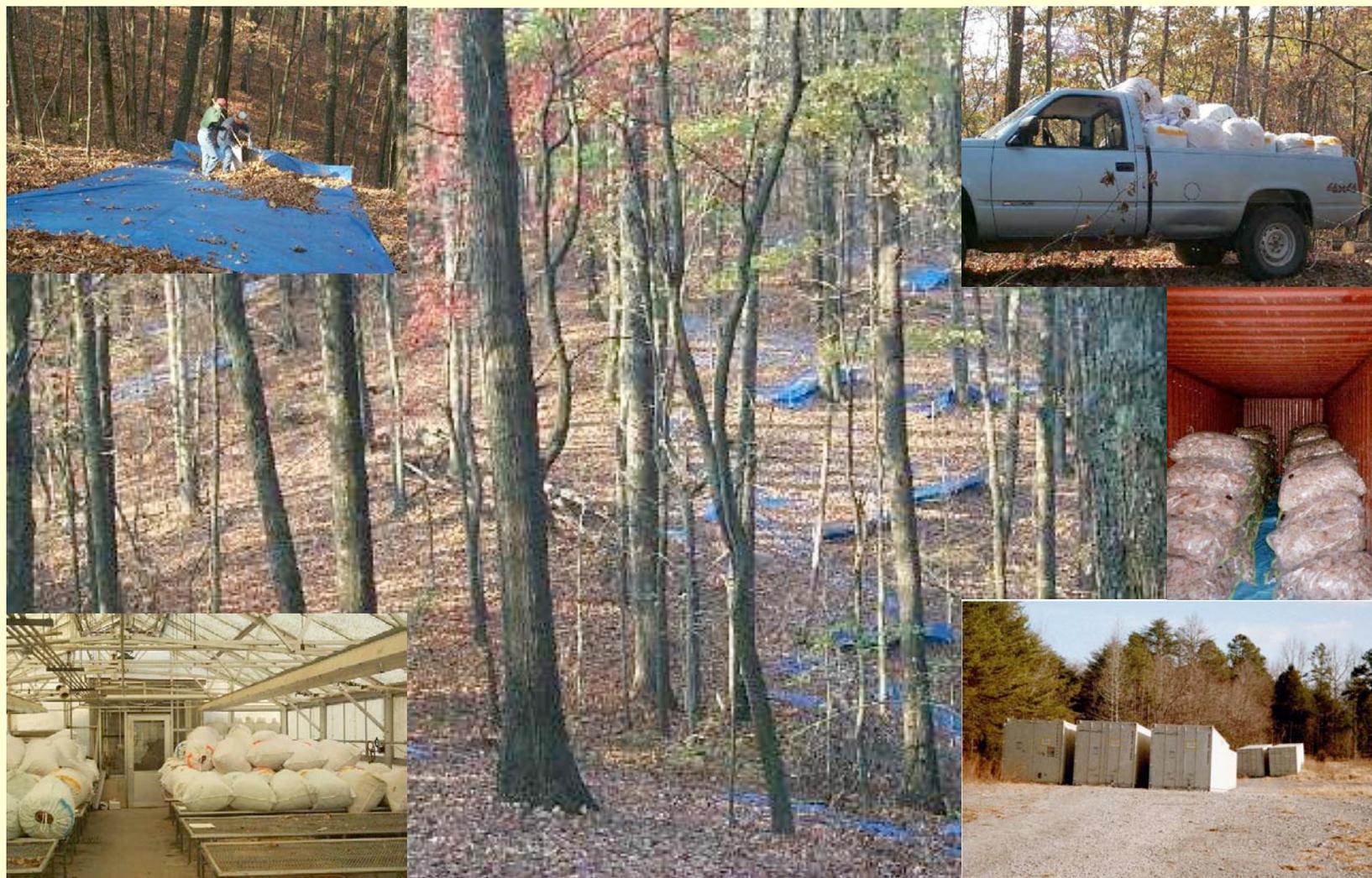
Trumbore et al. 2002

# Record of the $^{14}\text{C}$ -Pulse in Tree Rings



- The  $^{14}\text{C}$  signature in the local tree ring record demonstrated the unique and unprecedented nature of the 1999 event.
- $^{14}\text{C}$  in 2000 expanding foliage and buds confirmed the 1999 whole-ecosystem label and suggested that the ecosystem signature could be exploited for other studies.

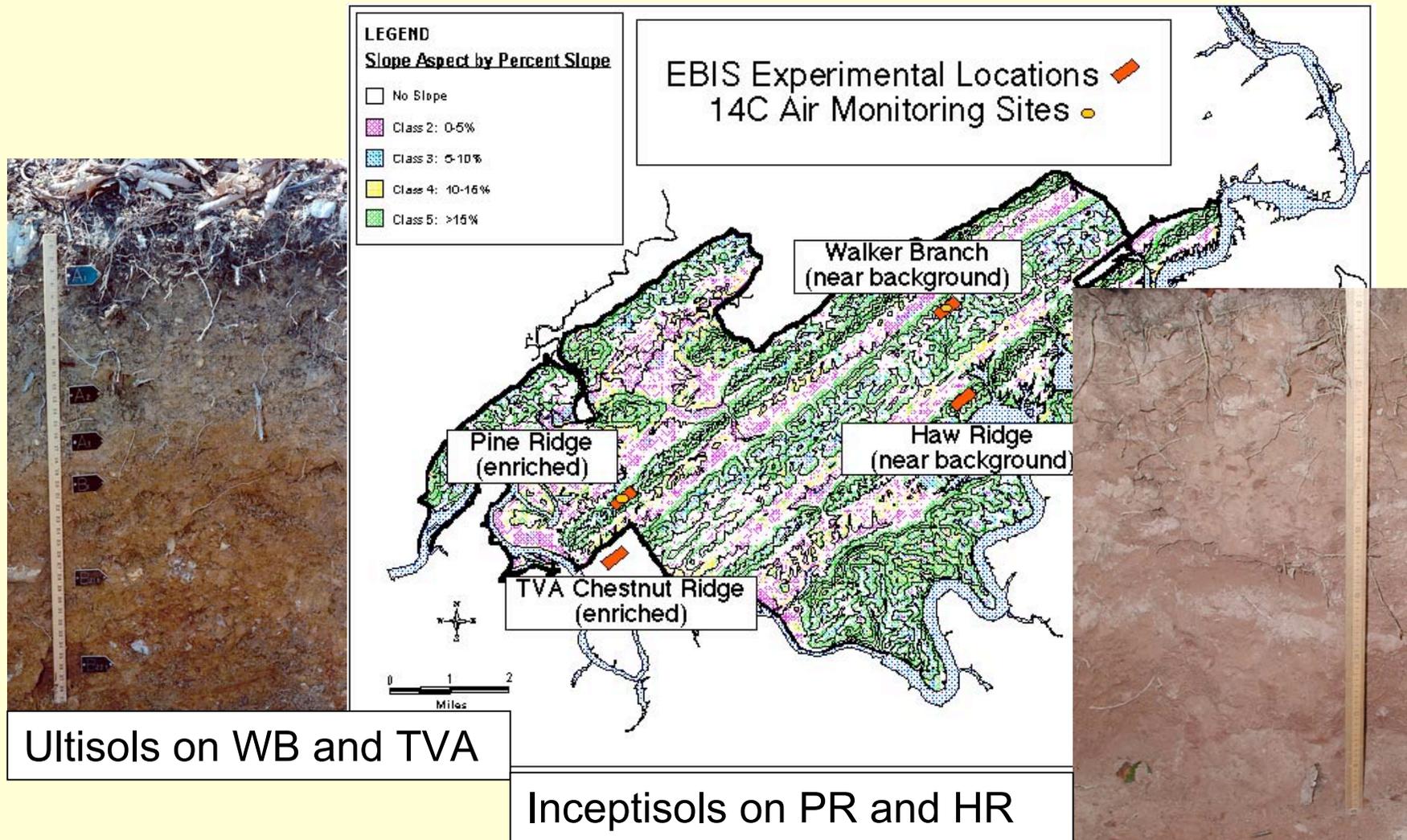
# Archiving $^{14}\text{C}$ Enriched Litter - 2000



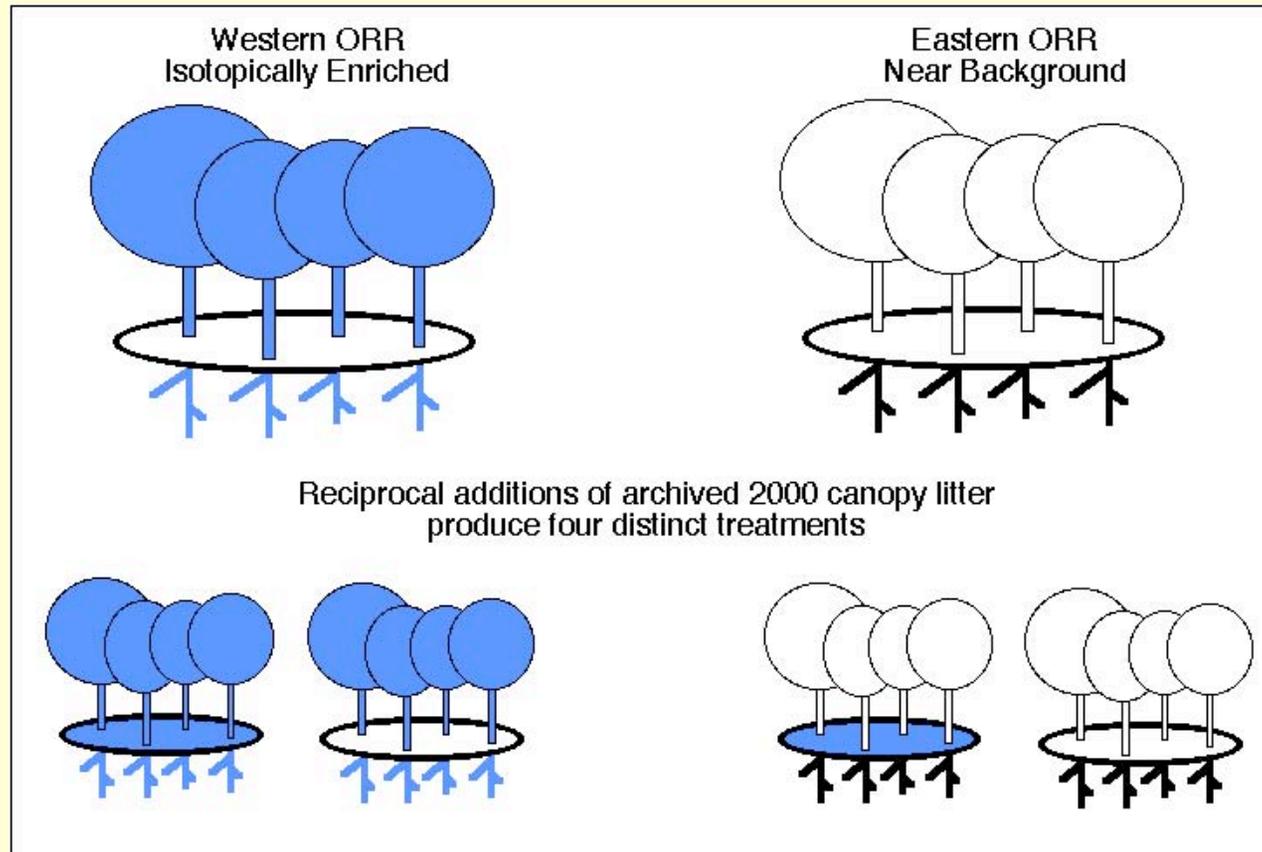
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# Two Soil Types are Being Studied

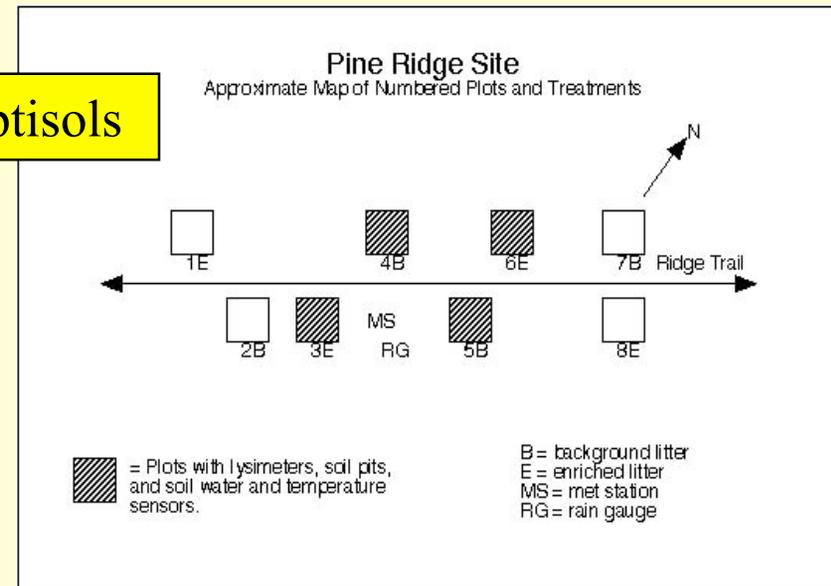
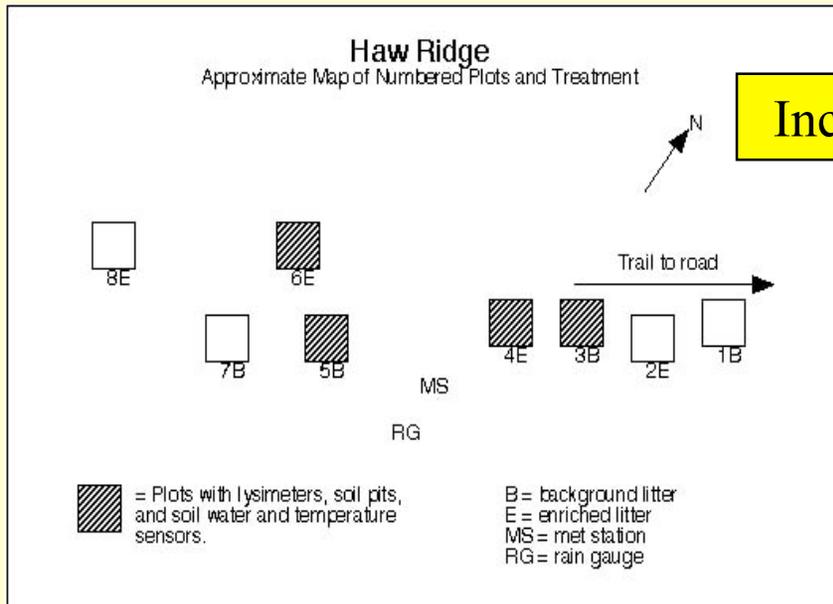


# A Multi-factor Design was Suggested by the Local Circumstances

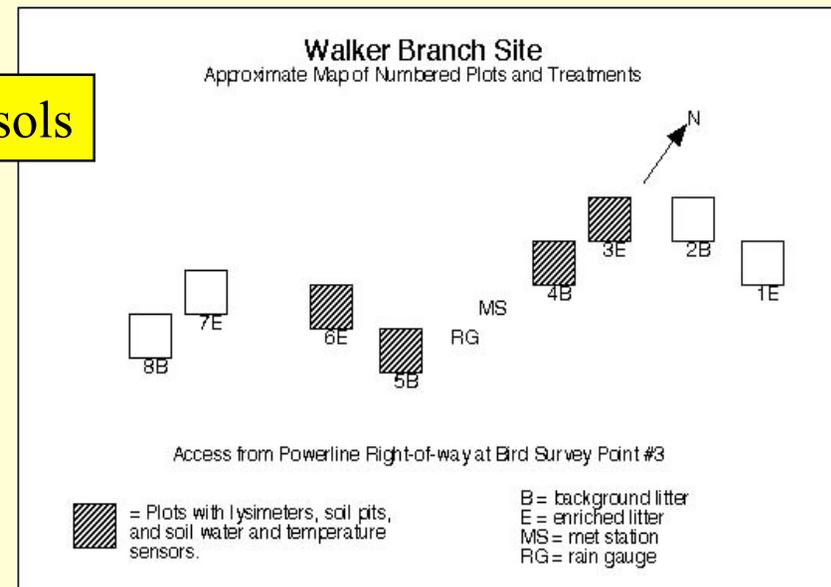
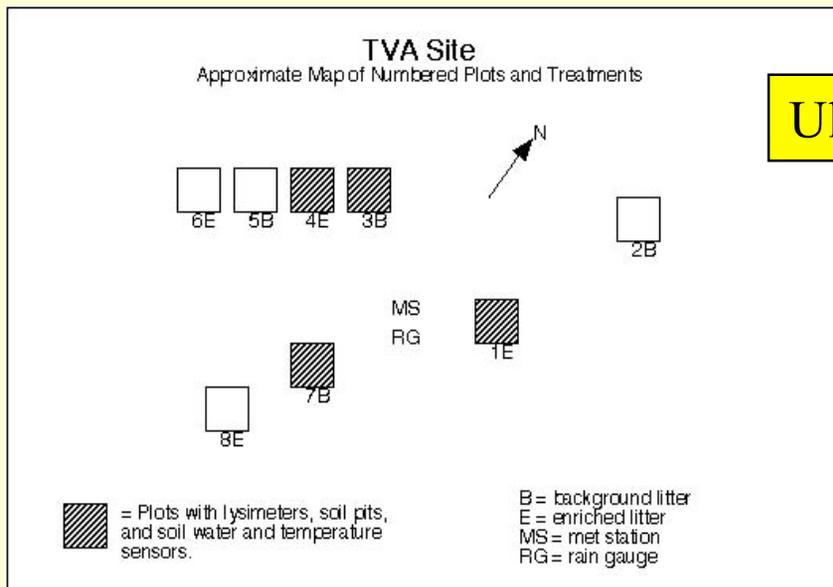


- The 1999-canopy-litter was significantly enriched. This was unexpected because the leaves were constructed prior to the pulse.
- Root  $^{14}\text{C}$ -signatures of the 'root-enriched plots' continue to change with ambient conditions (a declining root  $\Delta^{14}\text{C}$ -signature with time).

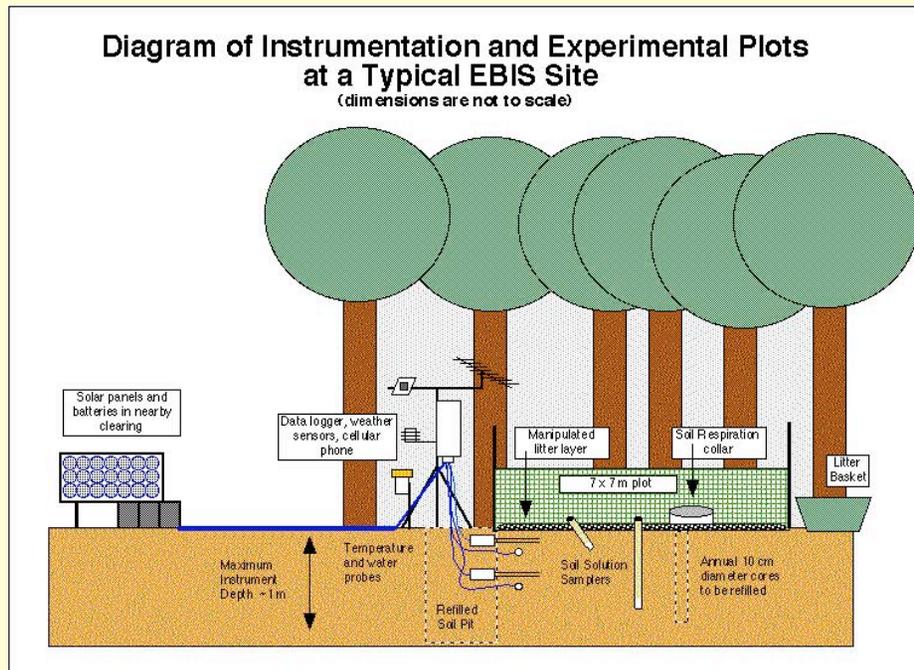
## Inceptisols



## Ultisols



# Replicate 7x7 m Plots Were Established at 4 Sites



- **Eight plots were established at each site. Half receive enriched litter each year and the other half receive background litter. Ambient litterfall is excluded from all plots (see photo).**

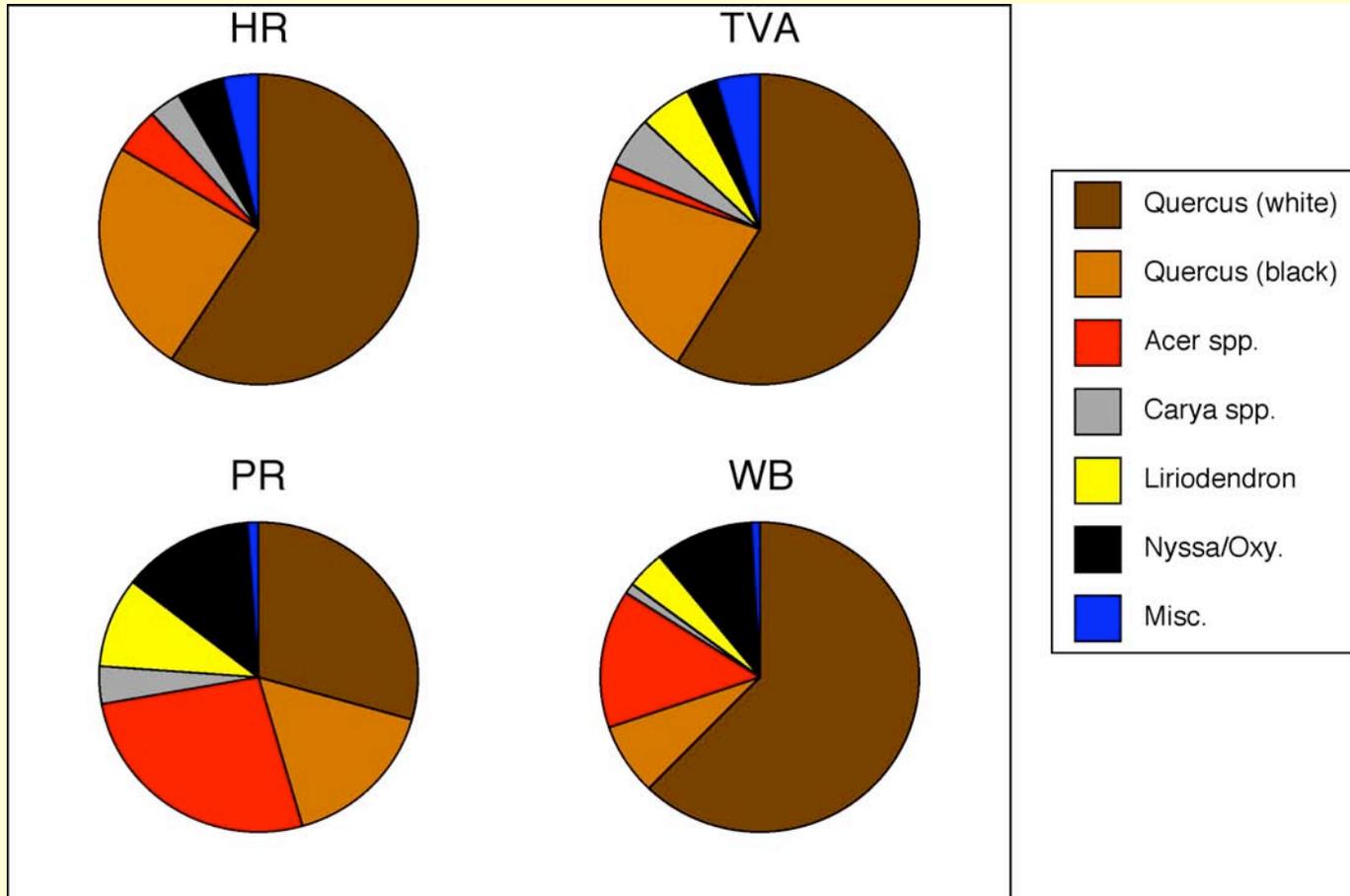


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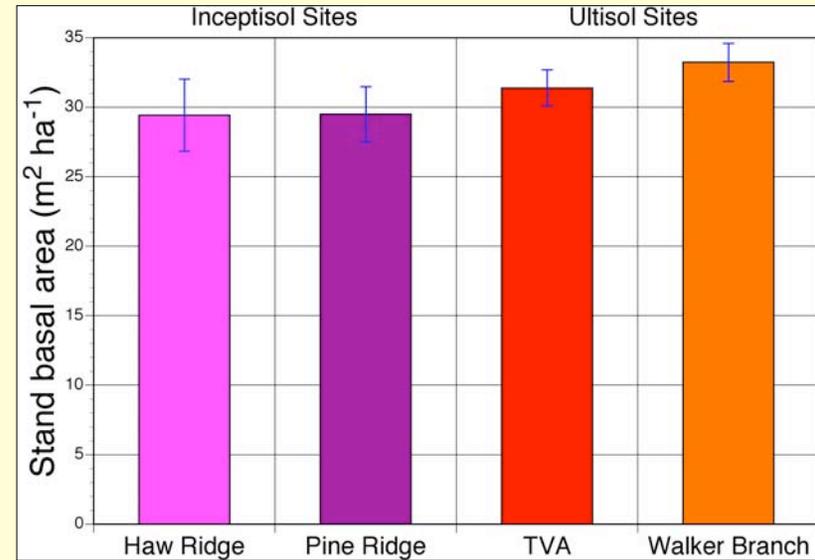
# Quercus (oak) Dominated Forests

[Acer litter contributions on Pine Ridge could impact decomposition]

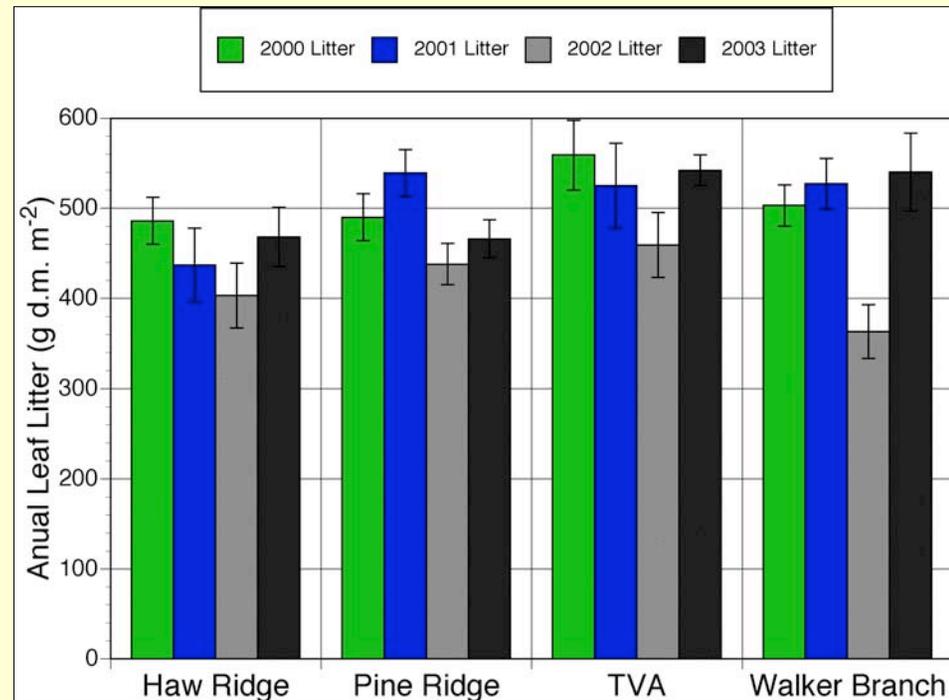


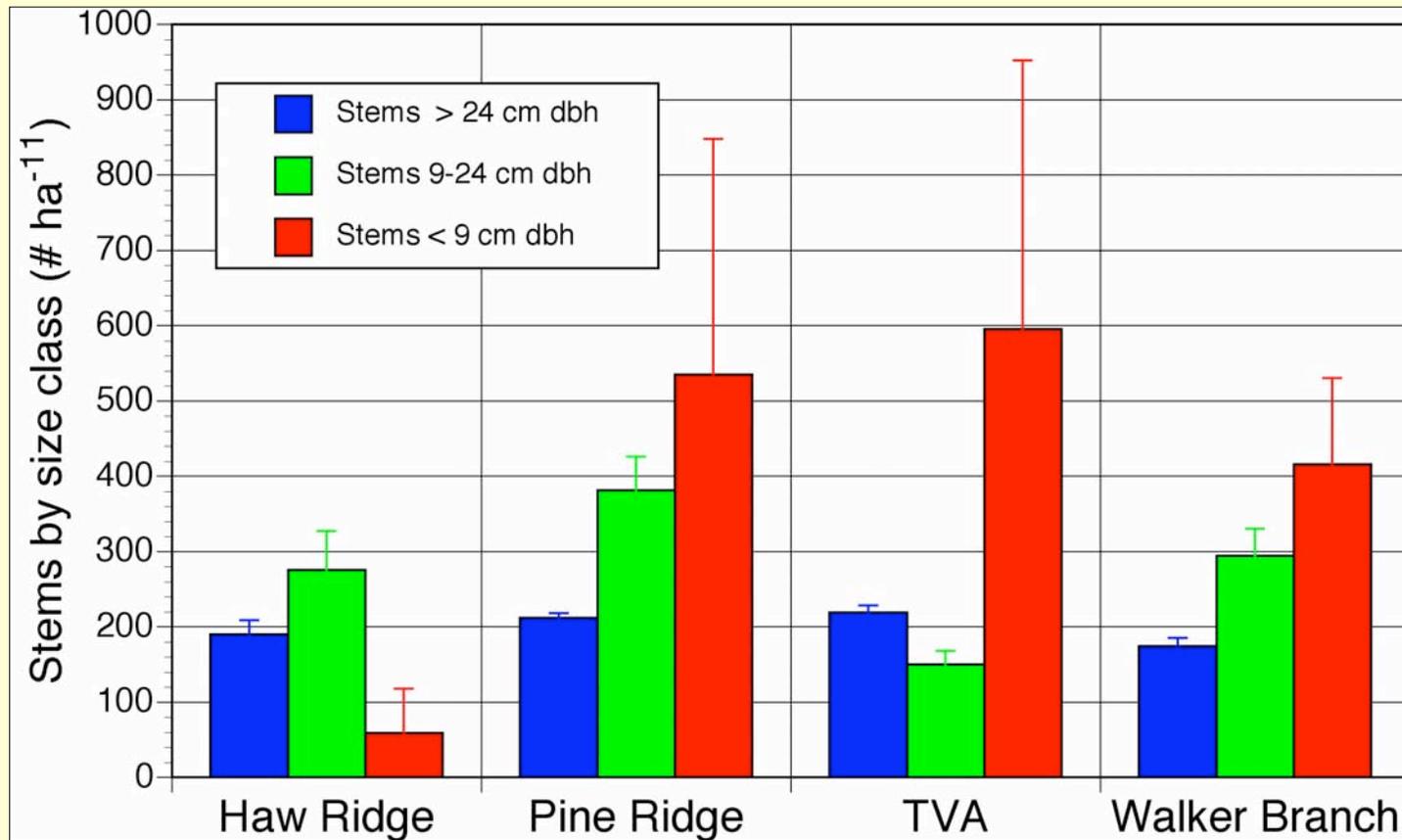
## Similar Vegetation

Basal areas of all sites covered a limited range from 28 to 34  $\text{m}^2 \text{ha}^{-1}$



Foliar litter production at all sites is  $\sim 500 \text{ g m}^{-2} \text{ y}^{-1}$

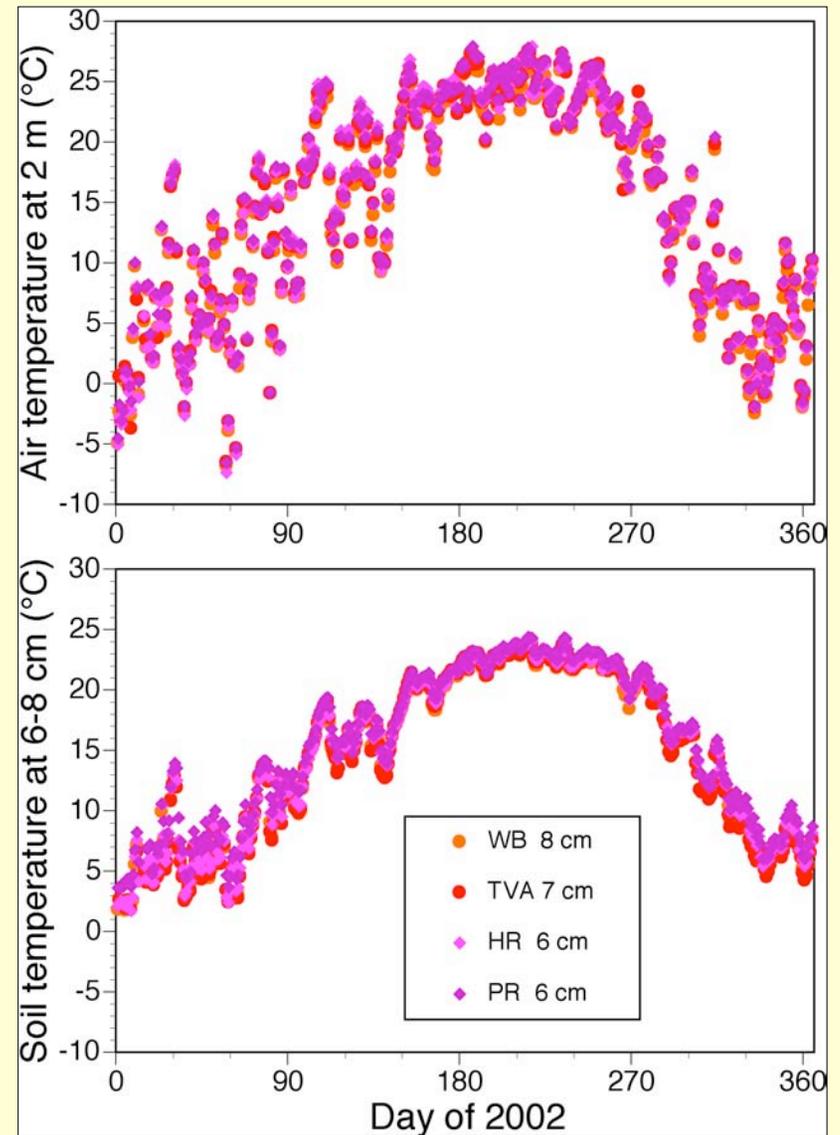
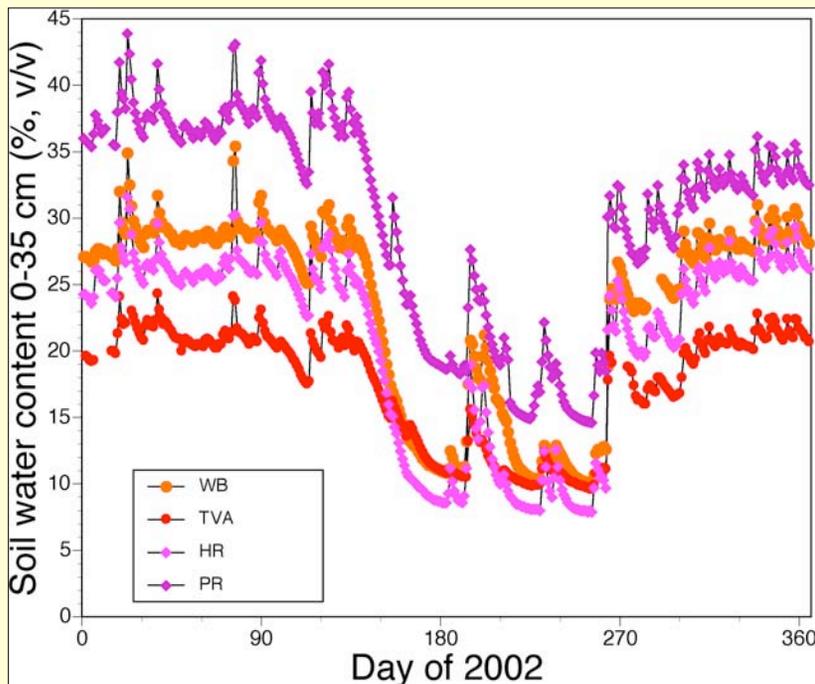




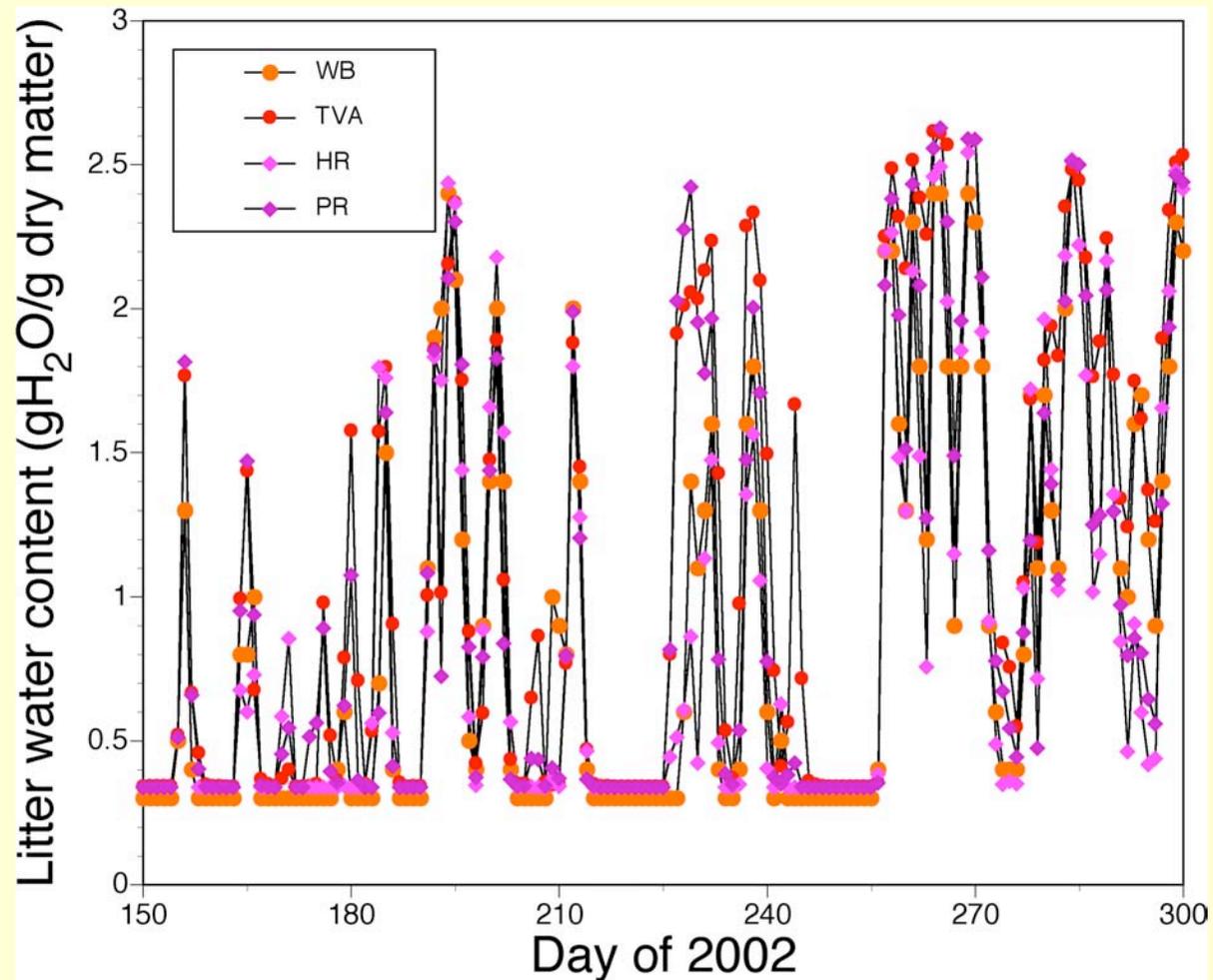
Reduced numbers of small (or young) stems at Haw Ridge may indicate an older forest.

# Environment

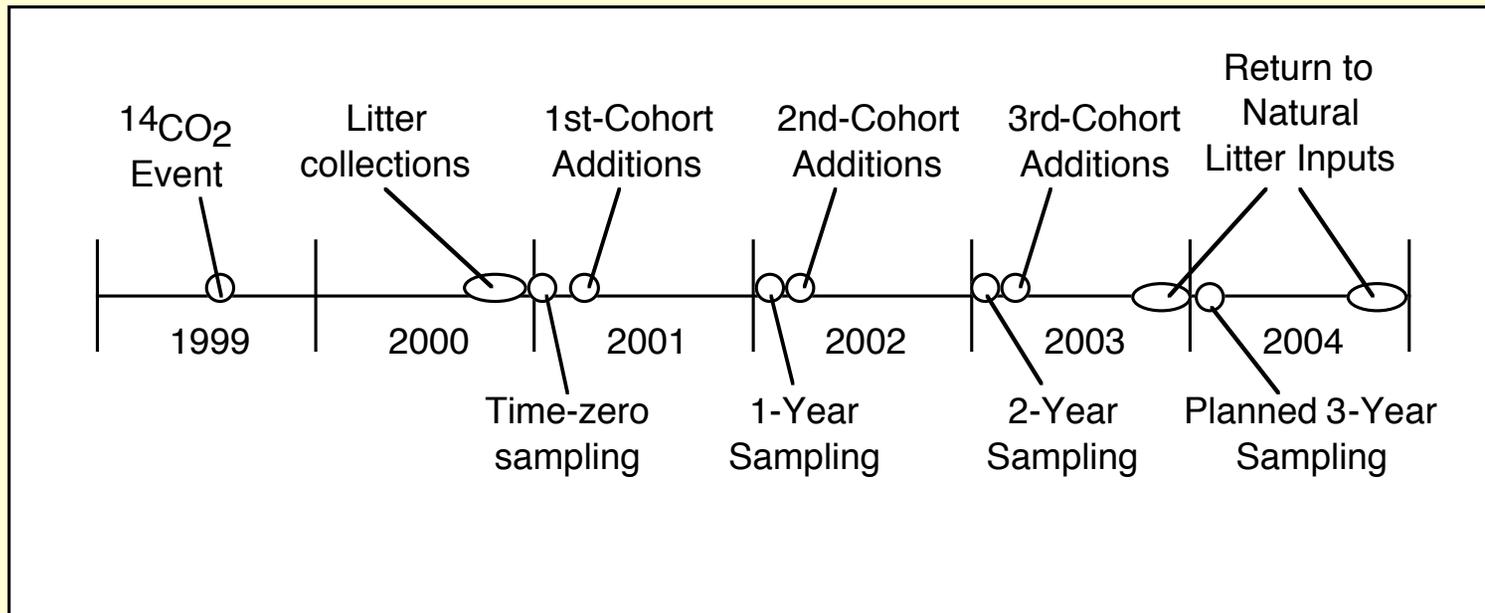
- Similar air, litter and soil temperatures were found at all 4 sites.
- Water status of the soil and litter layer is also consistent among sites, but isolated summer rains can yield minor differences.



# Litter-layer Water Content



# EBIS Activities to Date



- **Startup funds obtained from DOE 2000/2001**
- **Experimental plots established Fall 2000**
- **DOE multi-institution science funding began Oct 2001**
- **Initial publication -- June 2002 Trumbore et al. EOS 84:265,267-8.**

# **EBIS Tasks and Responsible Institutions**

- **Operation of the experiment - ORNL**
  - Field manipulations and environmental observations
  - Annual sampling for bulk changes - ORNL/LLNL
- **<sup>14</sup>C Analyses - CAMS/LLNL**
  - CAMS is accommodating more samples
  - Approximately 2500 samples run so far
- **Components of soil respiration - UC-Irvine**
  - Soil respiration and gas wells
- **Fine root turnover - UC-Santa Cruz and BGFR**
- **Vertical transport**
  - Dissolved organic carbon - ORNL
  - Macrobiodiversity mediated - USFS/UGA
- **Fate of mineral soil C in protected and unprotected forms**
  - Aggregate-based separations - ANL
  - Density-based separations - LBNL/LLNL
- **Integration and modeling**
  - Rothamsted model - ORNL
  - Root turnover - LBNL, UC-Santa Cruz
  - Organic layer decomposition - ORNL, LLNL