EBIS SOIL CARBON & NITROGEN

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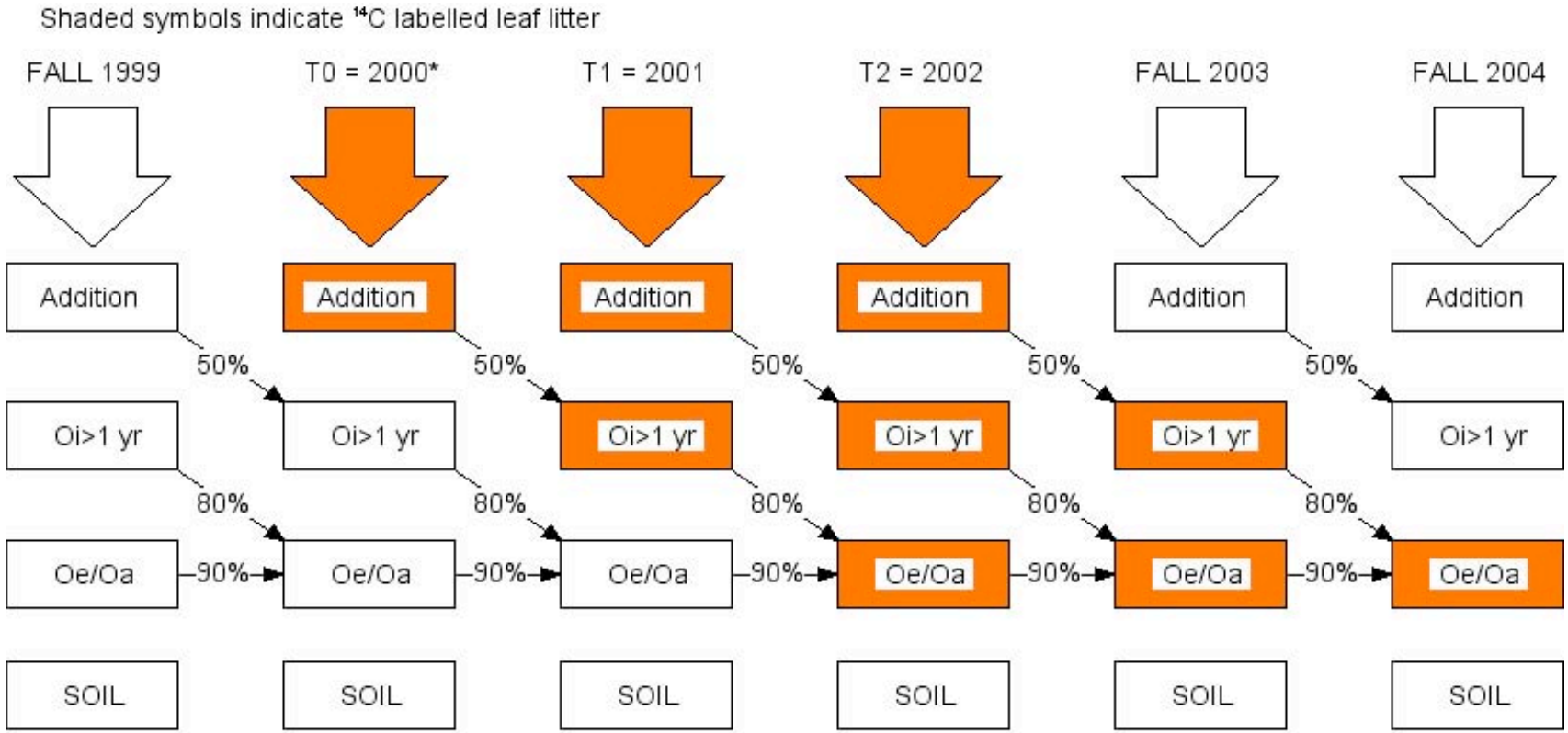
COMPARTMENTS & TIMING

- Litter additions, Oi > 1 year, Oe/Oa,
- Mineral soil (0-15, 15-30, 30-60, 60-90 cm)



* Ambient litterfall was excluded starting in Fall 2000

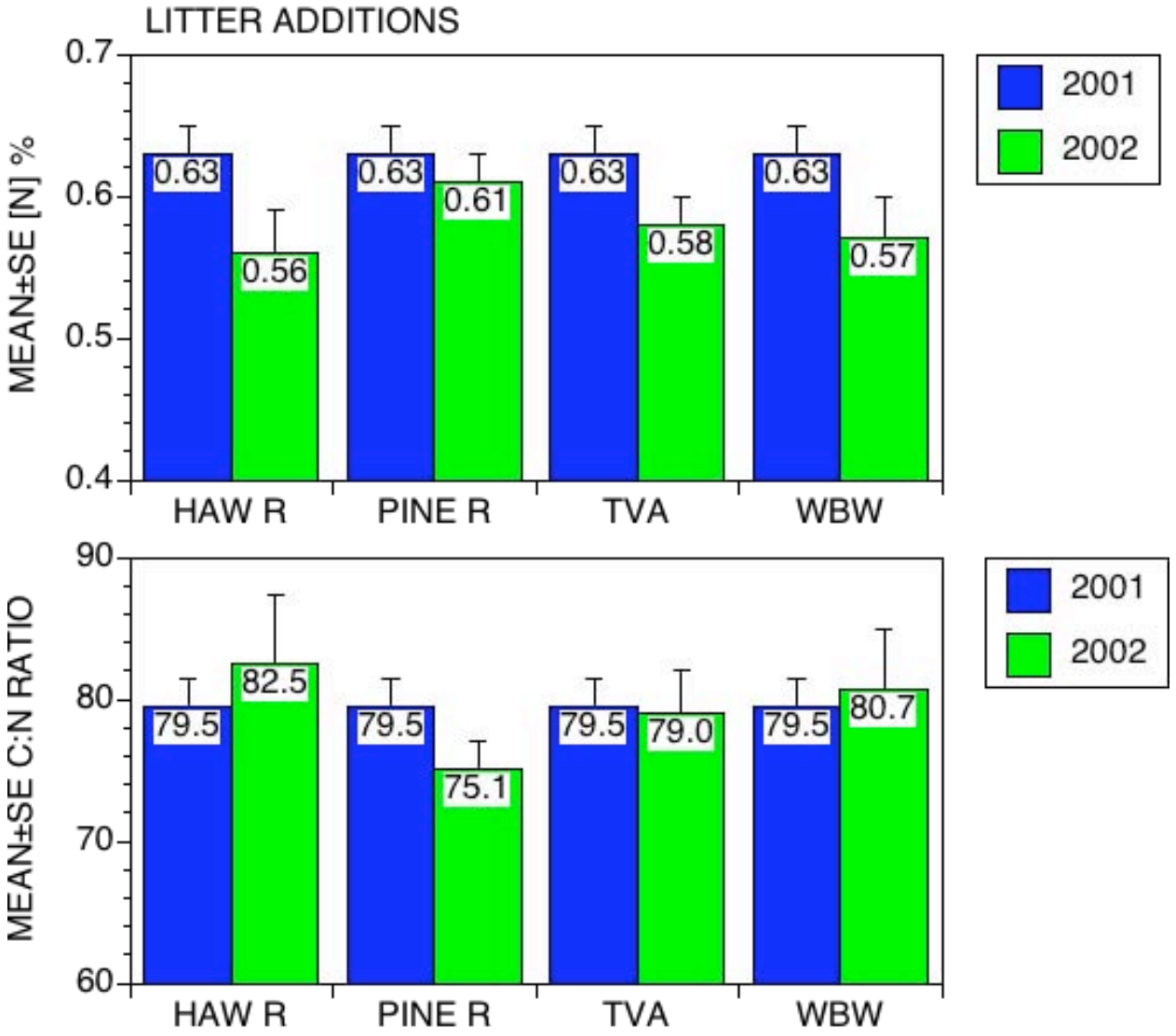
ANALYSIS, QA/QC, CALCULATIONS

- Instrument: LECO CN-2000
- Soil samples were analyzed twice
- Calibration samples traceable to NIST
- Sample to standard ratio was 10:1
- Measured/expected ratio for soil standards was 0.998 (n = 24)
- Calculation of litter C or N stock (g element m^{-2}):

  = dry mass (g m^{-2}) • concentration (g element g^{-1})
- Calculation of soil C or N stock (g element m^{-2}):

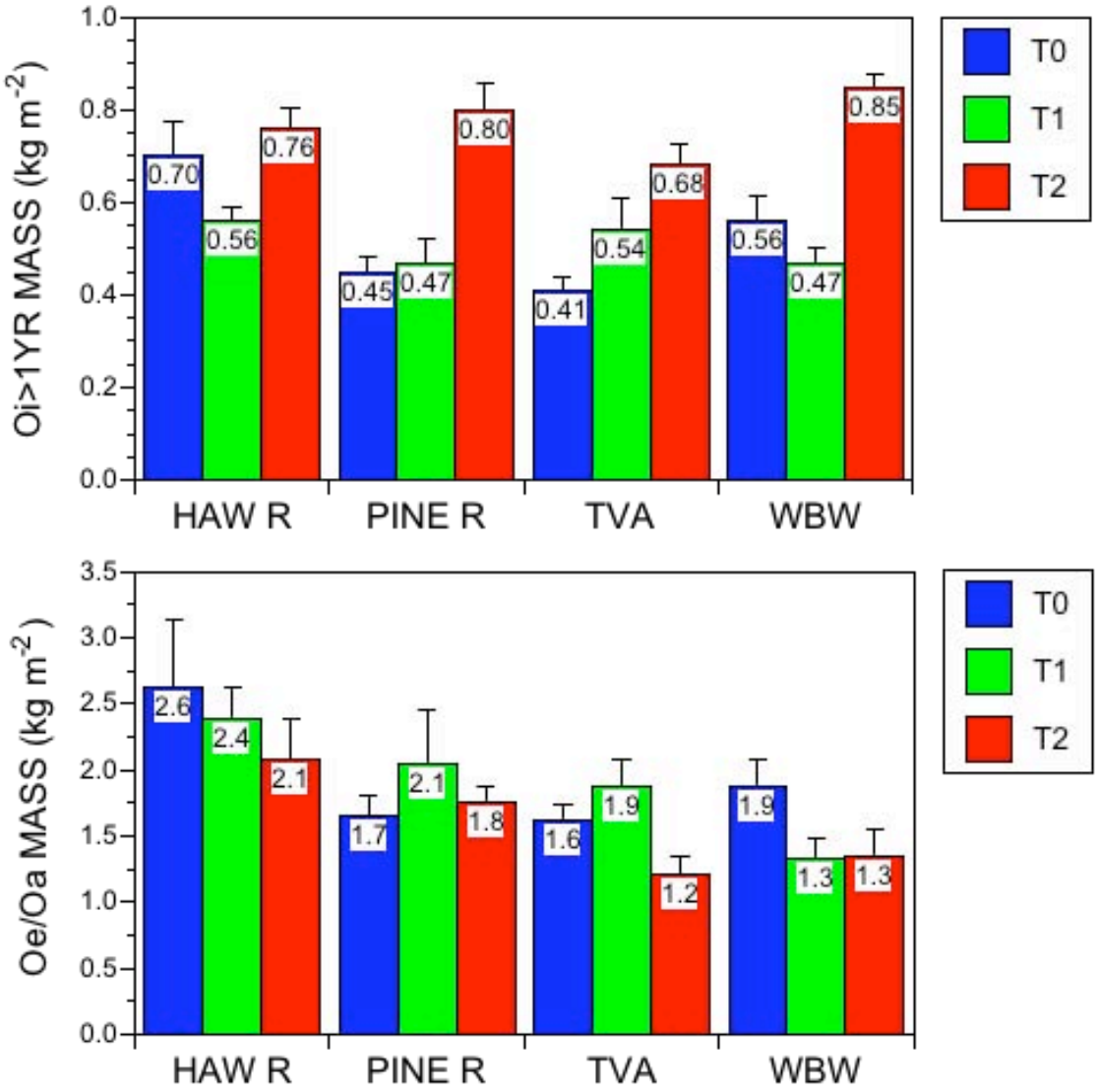
  = reference density (g soil cm^{-3}) • soil depth (cm) • concentration (g element g^{-1}) • 10000 cm^2 m^{-2}

LITTER ADDITIONS



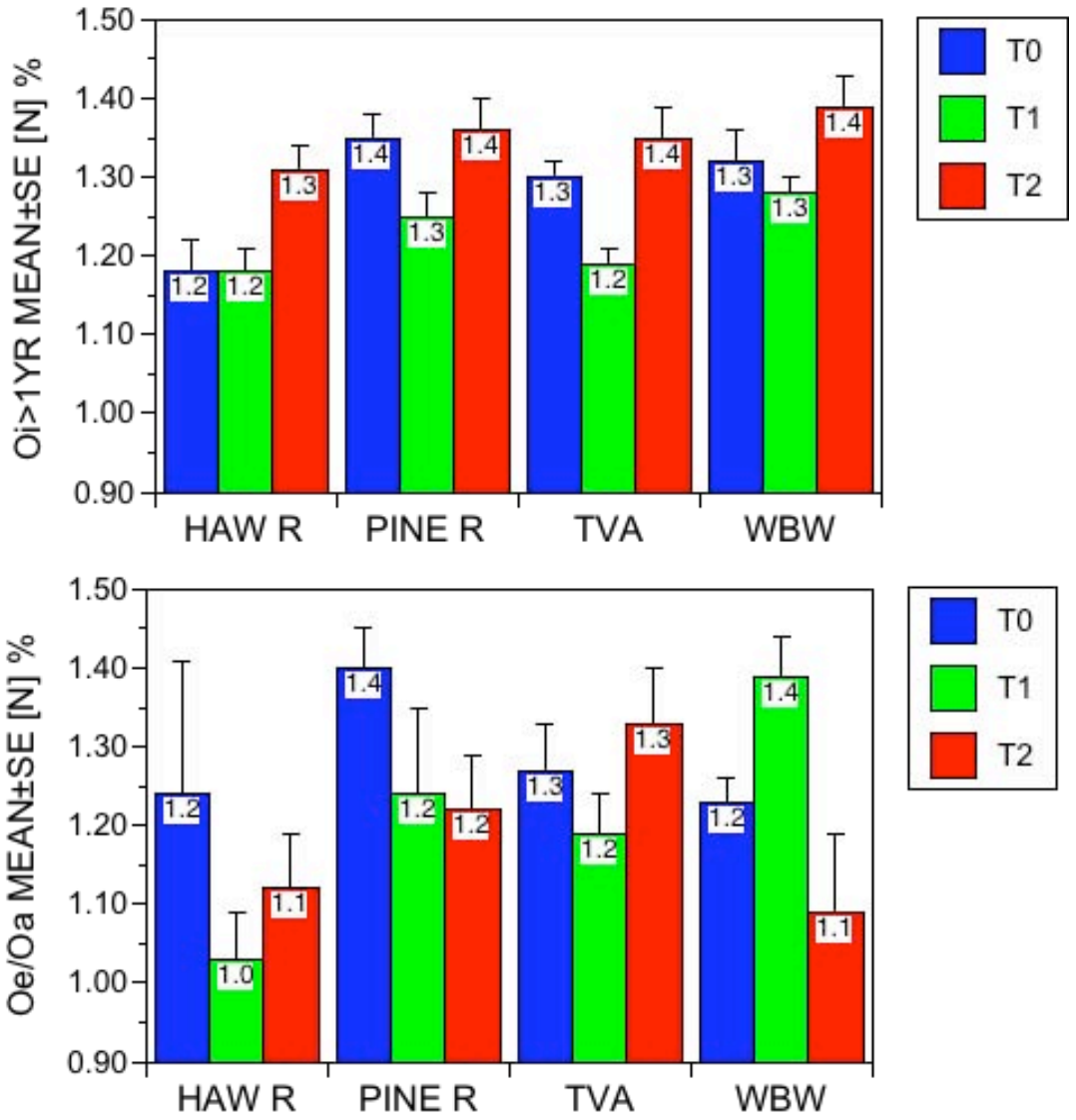
- Composite litter addition sample in 2001 (T1) and site specific data in 2002 (T2)
- N conc. in litter additions are ≈ 0.6%
- C:N ratio in litter additions is ≈ 80

FOREST FLOOR MASS



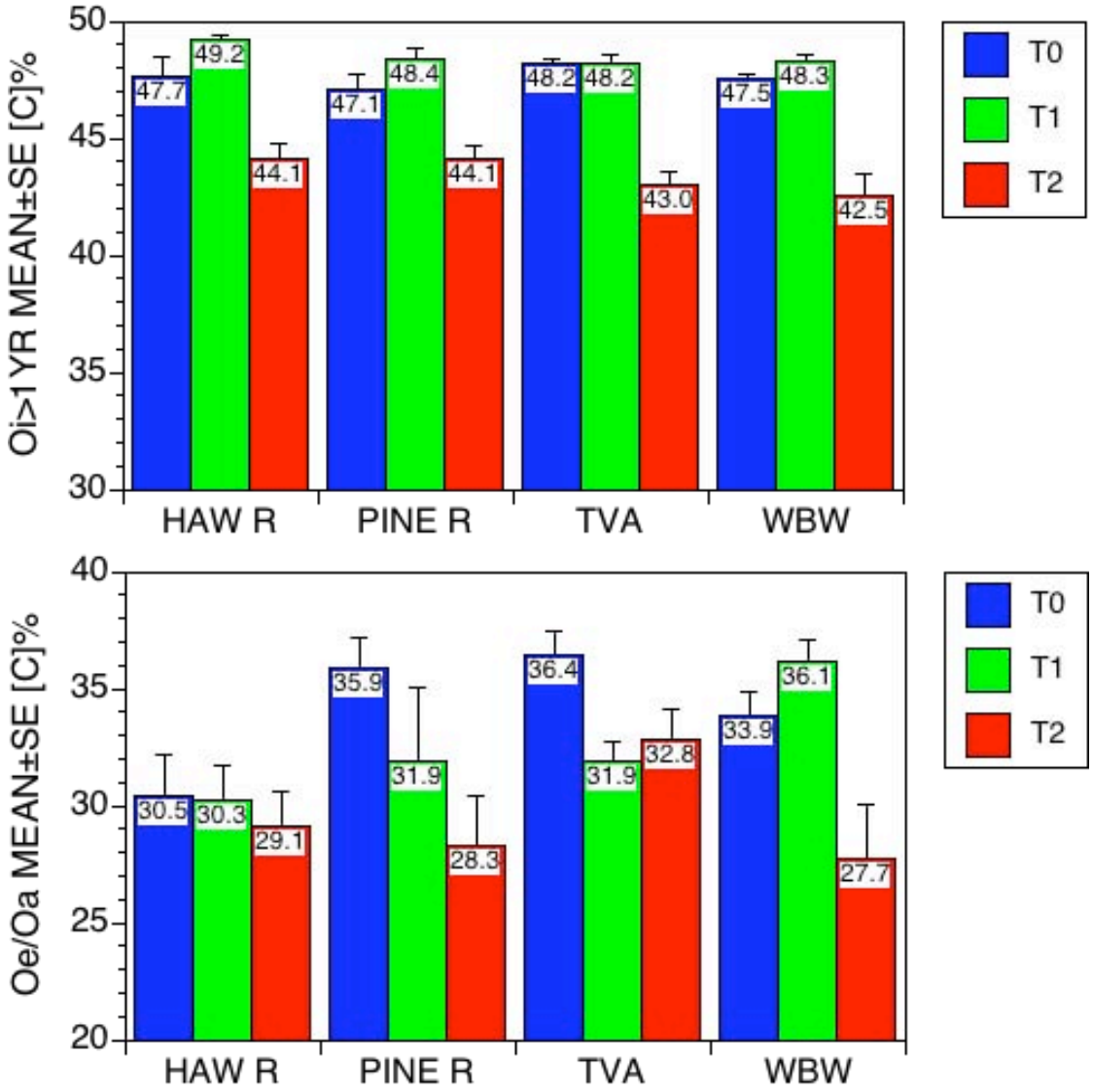
- Trend indicates increasing dry mass of Oi> 1YR over time at each site.
- Trend indicates decreasing Oe/Oa dry mass over time at each site.
- Although we can't rule out possible sampling errors as a cause for the temporal trend, weather conditions from 2000 through 2002 do favor accumulation of Oi-layer carbon.

FOREST FLOOR N CONCENTRATIONS



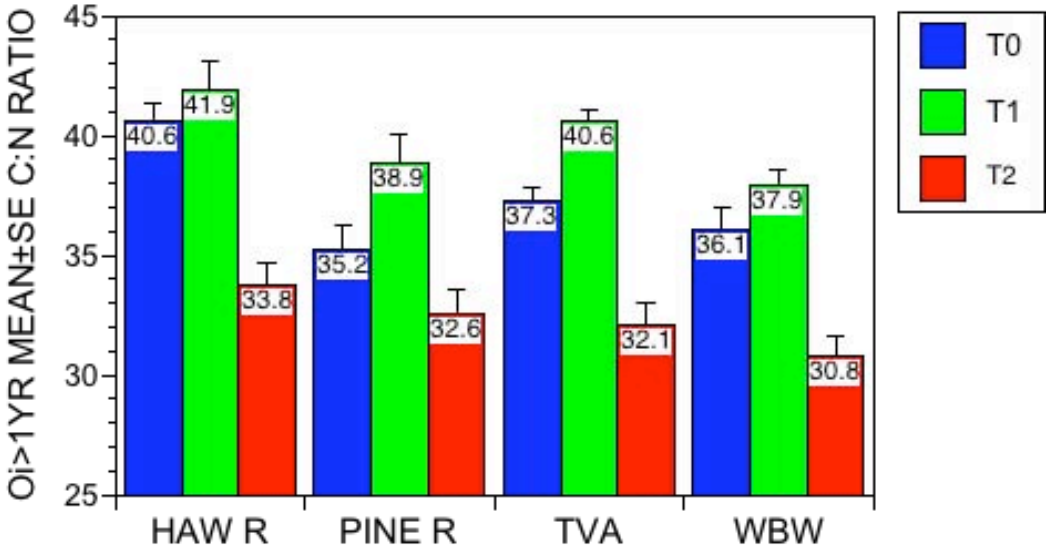
- On average, N concentrations in the Oi> 1YR and the Oe/Oa range from 1.0 to 1.4%
- For the Oi> 1YR , N concentrations at T2 tend to be greater than those measured at T1

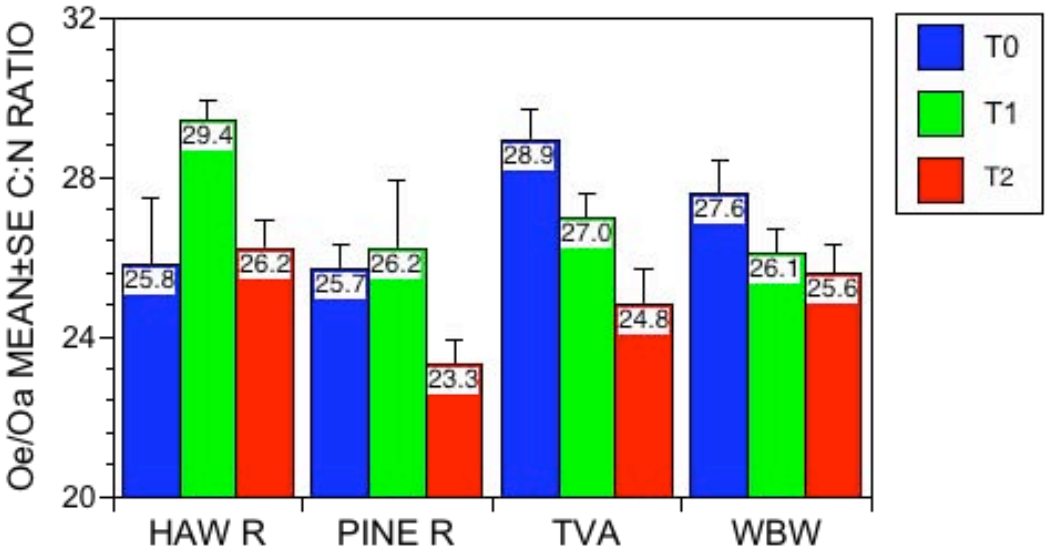
FOREST FLOOR C CONCENTRATIONS



- Trend for lower C concentrations at T2 in both the Oi> 1YR and Oe/Oa
- Concentrations in Oi> 1YR are greater than those in the Oe/Oa

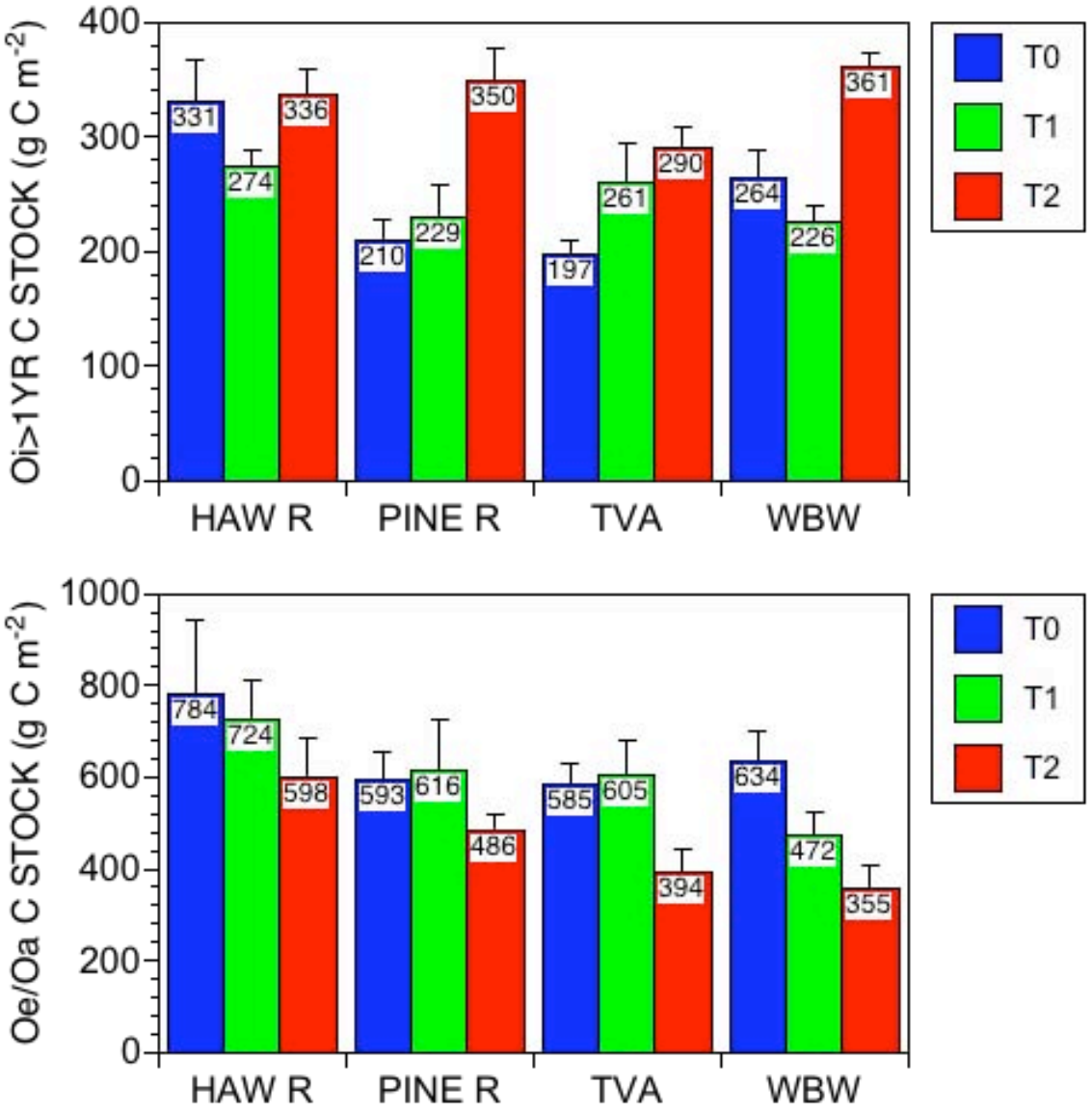
FOREST FLOOR C:N RATIOS





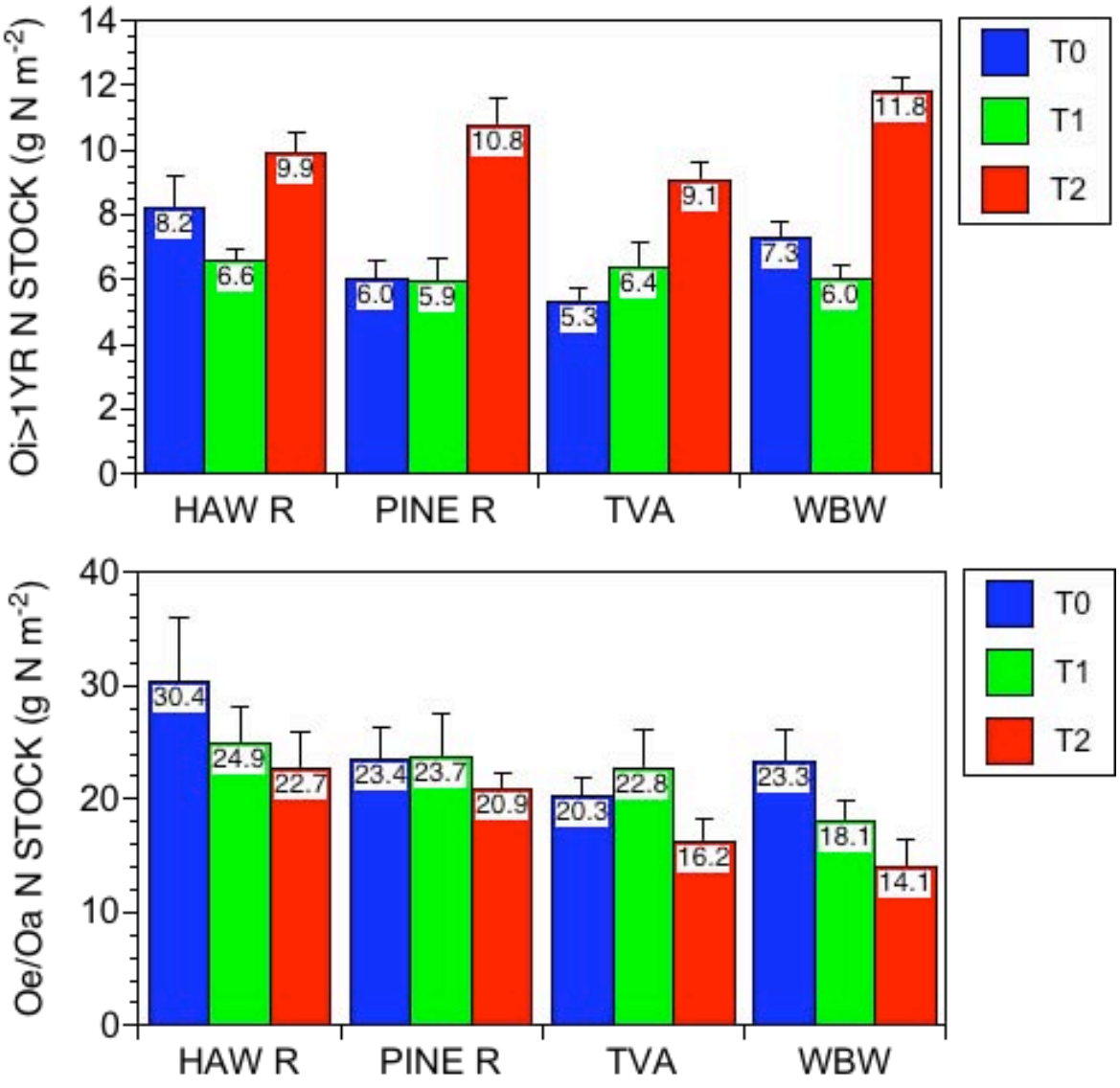
- C:N ratios in the Oi> 1YR are 31 to 42 and those in the Oe/Oa are 23 to 29
- Trend for decreasing C:N ratios over time in the Oe/Oa layer at most sites

FOREST FLOOR C STOCKS



- Trend for increasing C stocks over time in the Oi> 1YR at some sites (more mass)
- Trend for decreasing C stocks over time in the Oe/Oa layer (less mass)
- Generally, greater C stocks in the Oe/Oa than in the Oi> 1YR

FOREST FLOOR N STOCKS



- Trend for greater N stocks at T2 in the Oi> 1YR (more mass)
- Trend for declining N stocks over time in the Oe/Oa (less mass)
- Greater N stocks in the Oe/Oa than in the Oi> 1YR

SOIL REFERENCE DENSITIES

2002 Estimates

DEPTH	Haw Ridge	Pine Ridge	TVA	Walker Branch
0-15 cm	0.97	0.94	0.97	0.96
15-30 cm	1.08	0.96	1.00	1.02
30-60 cm	0.97	0.77	0.82	0.85
60-90 cm	1.01	0.66	0.71	0.73

2003 Estimates

DEPTH	Haw Ridge	Pine Ridge	TVA	Walker Branch
0-15 cm	0.671 ±0.050	0.533 ±0.056	0.577 ±0.032	0.716 ±0.043
15-30 cm	0.687 ±0.075	0.735 ±0.038	0.681 ±0.043	0.684 ±0.056
30-60 cm	0.771 ±0.048	0.819 ±0.025	0.647 ±0.047	0.739 ±0.019
60-90 cm	0.888 ±0.049	1.014 ±0.036	0.833 ±0.090	0.823 ±0.059

- Soil reference densities (g cm^{-3}) were revised in 2003
- For most increments, the revised reference densities are less than those used in prior calculations
- Soil C and N conc. have not changed since last year's meeting
- Revised soil C and N stocks are substantially less than those presented last year

SOIL C & N CONCENTRATIONS

Mean [N]%

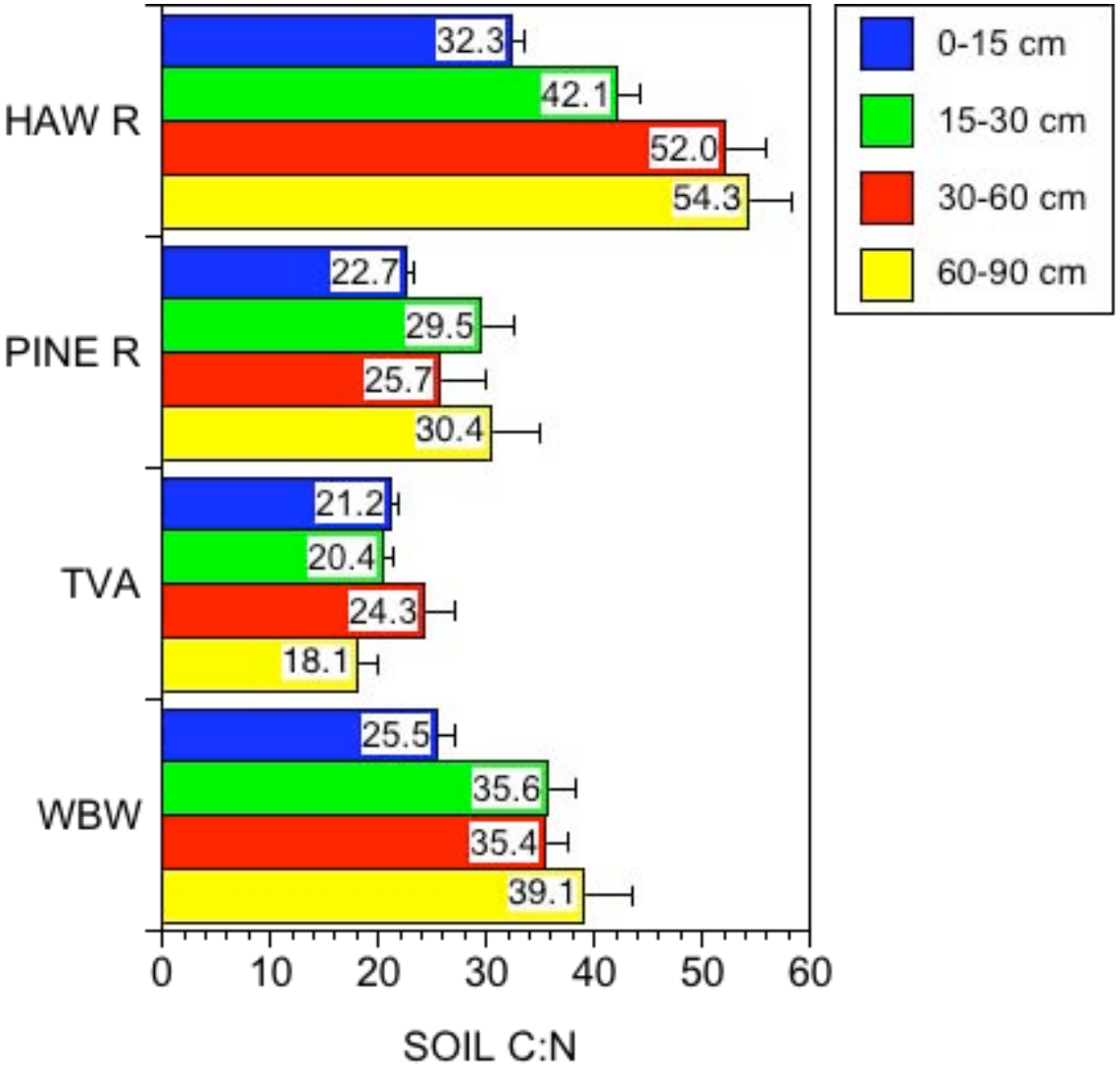
DEPTH	Haw Ridge	Pine Ridge	TVA	Walker Branch
0-15 cm	0.057	0.101	0.118	0.097
15-30 cm	0.012	0.022	0.042	0.017
30-60 cm	0.008	0.019	0.022	0.012
60-90 cm	0.006	0.013	0.014	0.007

Mean [C]%

DEPTH	Haw Ridge	Pine Ridge	TVA	Walker Branch
0-15 cm	1.861	2.265	2.487	2.489
15-30 cm	0.490	0.580	0.850	0.589
30-60 cm	0.388	0.395	0.475	0.399
60-90 cm	0.303	0.322	0.247	0.225

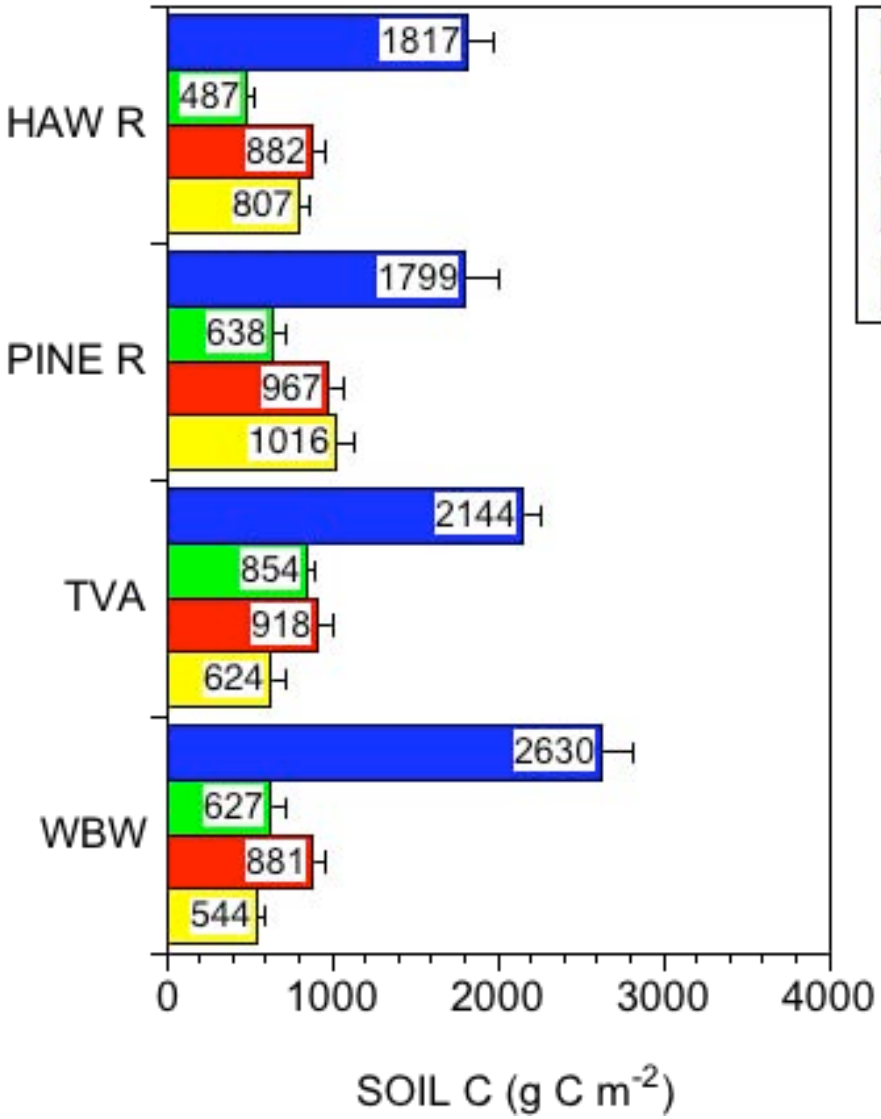
- No change in mean soil N and C concentrations from last year
- Lower surface soil N and C concentrations at Haw Ridge site

SOIL C:N RATIOS

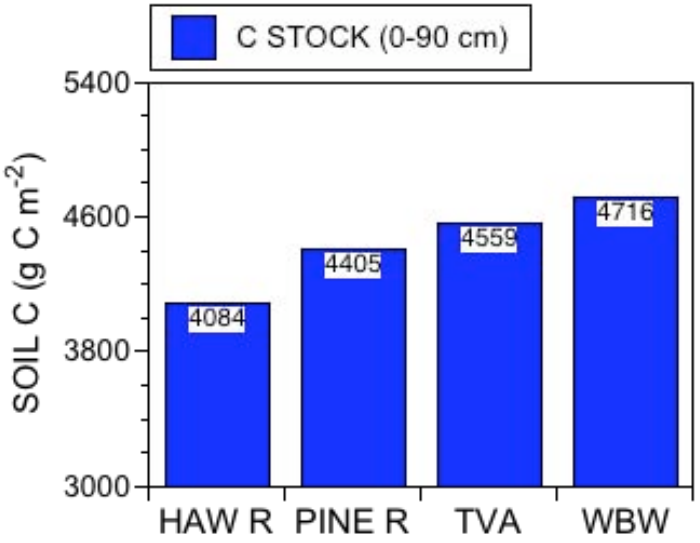


- Lower C:N ratios at Pine Ridge and TVA sites

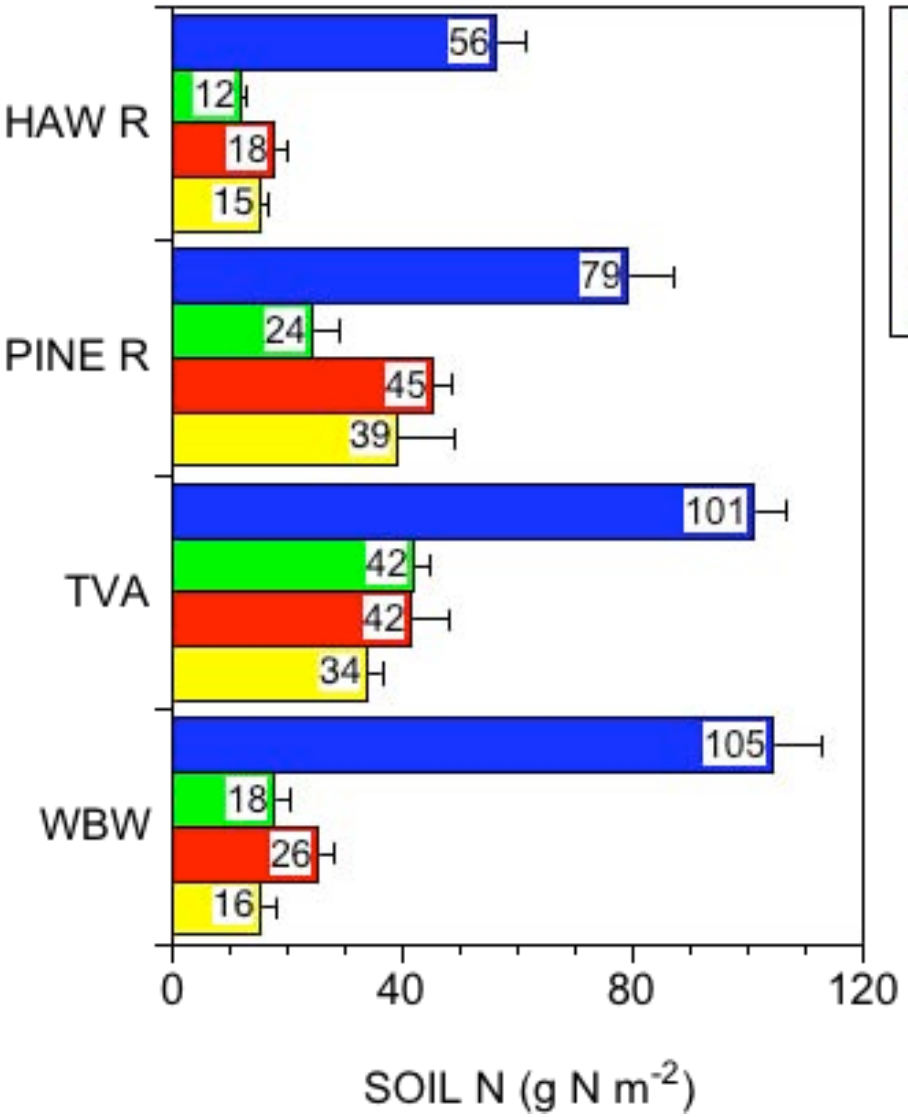
REVISED SOIL C STOCKS



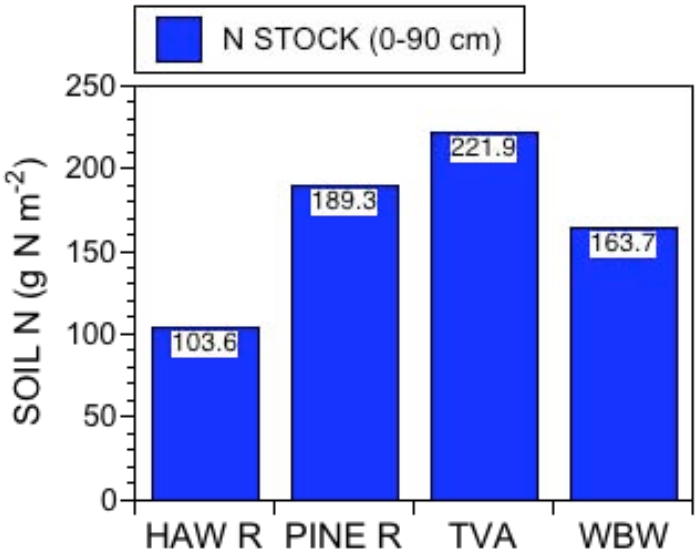
- Less C on shale sites
- Most of the soil C at these sites is in the 0-30 cm soil increment



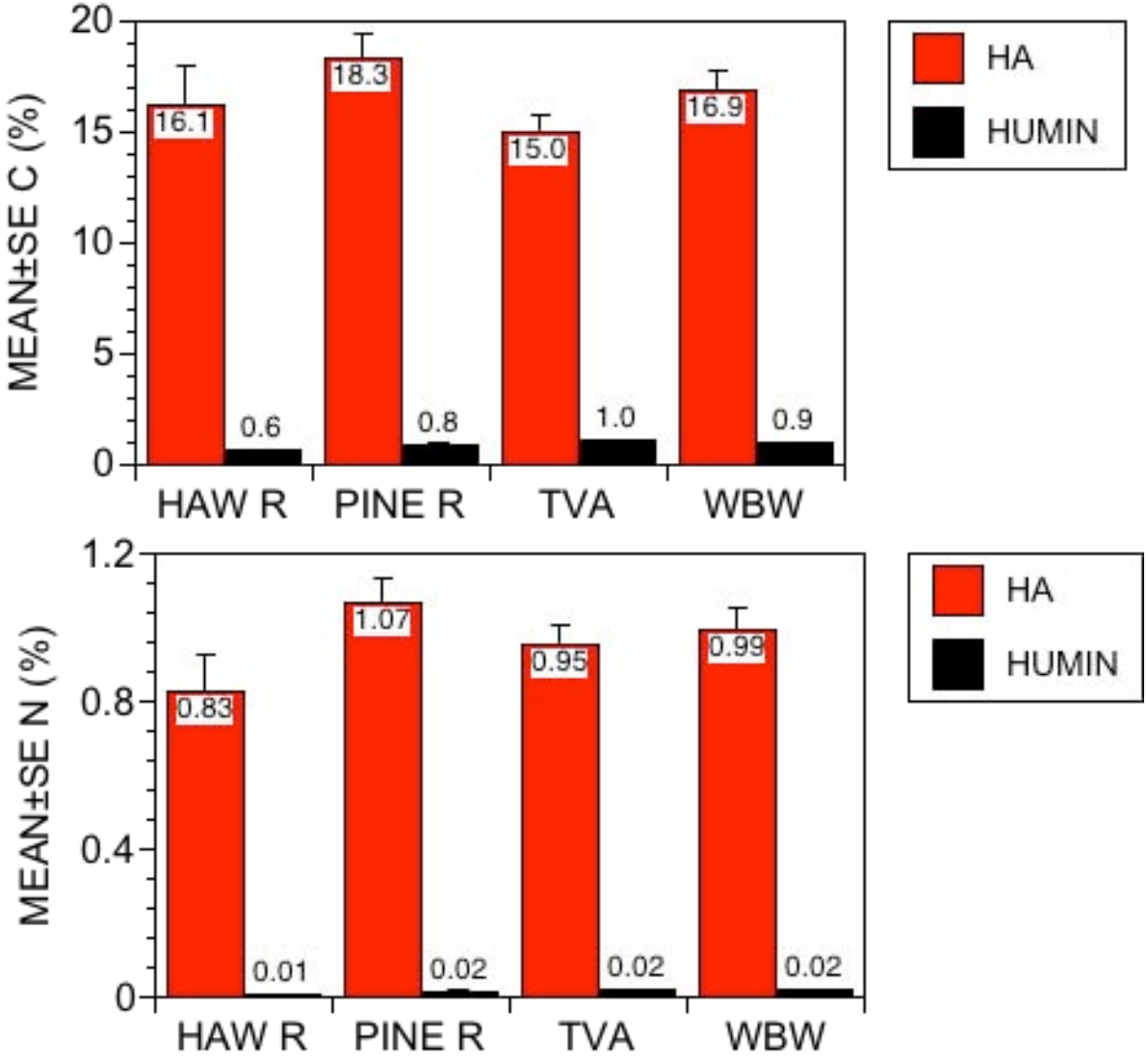
REVISED SOIL N STOCKS



- Haw Ridge has the lowest soil N stocks
- TVA site has the highest soil N stocks

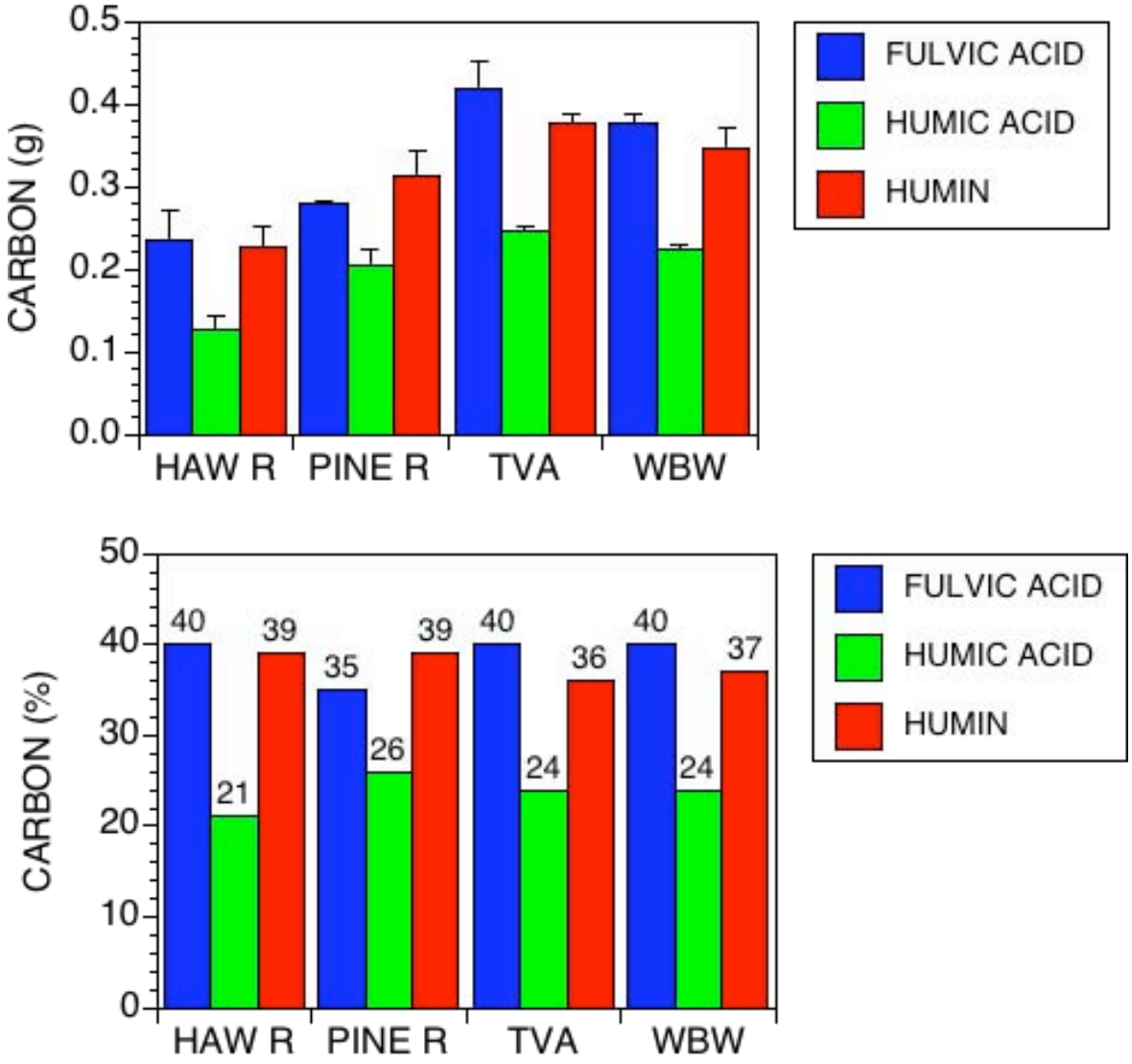


C & N IN HUMIC ACIDS & HUMIN



- Analyzed four 0-15 cm increment samples from each site
- C and N in humin and humic acid (HA) were measured directly
- C in fulvic acid fraction was estimated by mass balance
- No strong differences among the four sites

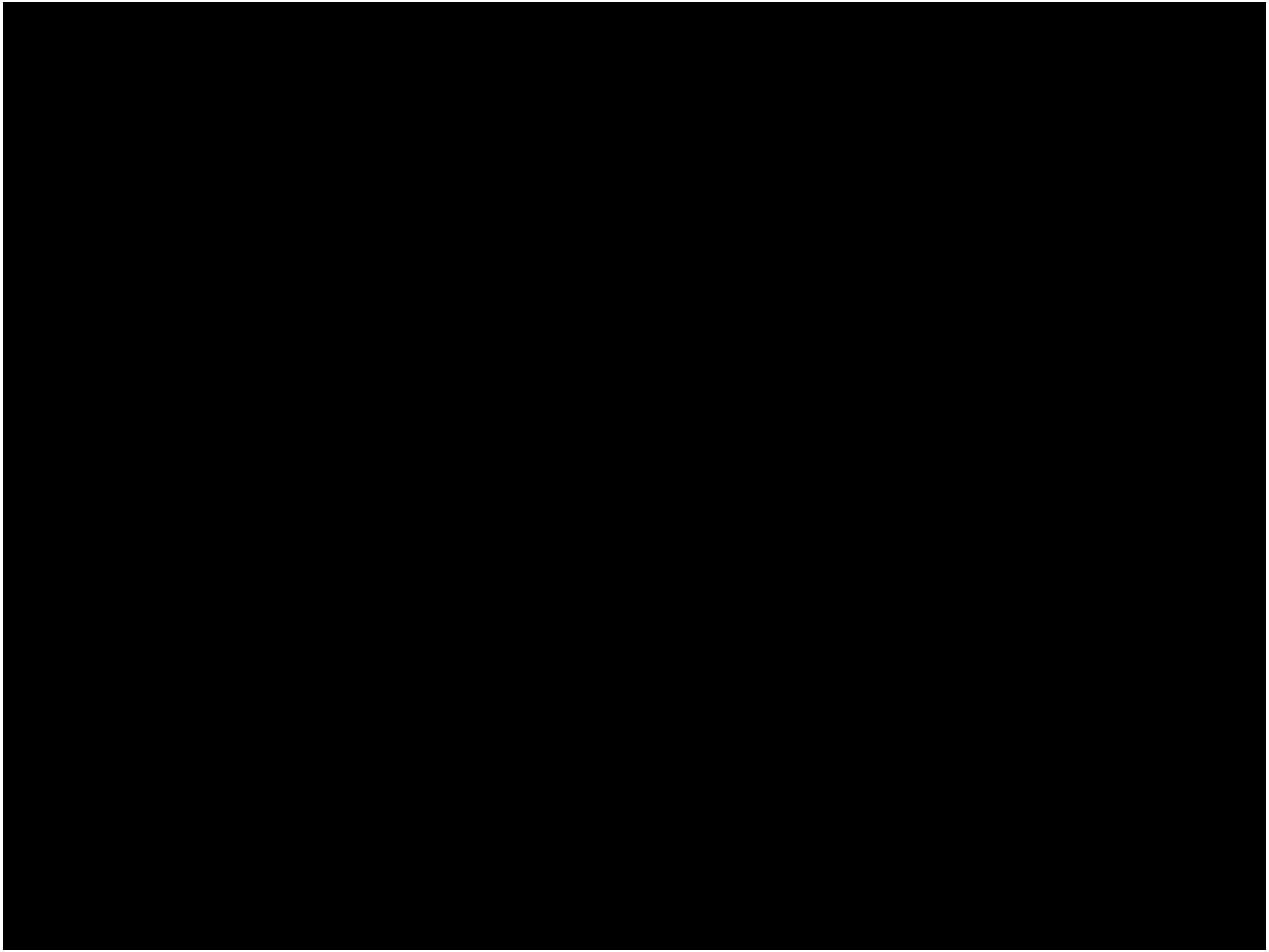
HUMIC ACID EXTRACTIONS



- High percentage of soil C at all sites was associated with the fulvic acid fraction
- About 25% of the surface soil C was associated with humic acids

CONCLUSIONS

- Soil C and N stocks have been revised downward since last year's meeting because of revised soil densities
- Post revised calculations on the EBIS web site for all investigators
- Haw Ridge has the lowest soil C and N stocks
- Trend for increasing C and N stocks in the Oi>1YR and decreasing stocks in the Oe/Oa (associated with changes in dry mass over time)
- Most (75-80%) of the surface (0-15 cm) soil C at each site is associated with fulvic acid and humin fractions (≈25% in the humic acid fraction)



CHEMISTRY OF Oi ADDITIONS

TABLE
O-HORIZON: Mean (±SE) chemistry of the Oi additions in 2002 and 2003

Year	n	[N]%	[C]%	C:N
2002	8	0.63 ± 0.02	50.1 ± 0.20	79.5 ± 1.9
2003 (Haw Ridge)	4	0.56 ± 0.03	45.7 ± 0.08	82.5 ± 4.8
2003 (Pine Ridge)	4	0.61 ± 0.02	45.9 ± 0.08	75.1 ± 2.0
2003 (TVA)	4	0.58 ± 0.02	45.9 ± 0.02	79.0 ± 3.1
2003 (Walker Branch)	4	0.57 ± 0.03	45.5 ± 0.16	80.7 ± 4.3

O-HORIZON DRY MASS

TABLE
O-HORIZON: Mean (±SE) O-horizon dry mass (kg m-2) (n = 8)

Site	Fraction	2001	2002	2003
Haw Ridge	Oi>1yr	0.70±0.074	0.56±0.029	0.76±0.046
	Oe/Oa	2.61±0.513	2.38±0.250	2.07±0.323
Pine Ridge	Oi>1yr	0.45±0.034	0.47±0.053	0.80±0.059
	Oe/Oa	1.65±0.150	2.05±0.397	1.75±0.124
TVA	Oi>1yr	0.41±0.028	0.54±0.070	0.68±0.046
	Oe/Oa	1.61±0.125	1.87±0.200	1.20±0.141
Walker Branch	Oi>1yr	0.56±0.052	0.47±0.030	0.85±0.029
	Oe/Oa	1.88±0.204	1.33±0.156	1.34±0.208

O-HORIZON C CONCENTRATIONS

TABLE
O-HORIZON: Mean (±SE) C concentrations (% dw) in the O-horizons (n = 8)

Site	Fraction	2001	2002	2003
Haw Ridge	Oi>1yr	47.66±0.836	49.24±0.163	44.10±0.713
	Oe/Oa	30.46±1.698	30.28±1.409	29.11±1.487
Pine Ridge	Oi>1yr	47.13±0.585	48.42±0.451	44.10±0.585
	Oe/Oa	35.93±1.285	31.93±3.098	28.32±2.086
TVA	Oi>1yr	48.23±0.135	48.20±0.345	43.03±0.563
	Oe/Oa	36.43±1.021	31.89±0.875	32.84±1.331
Walker Branch	Oi>1yr	47.53±0.238	48.27±0.278	42.52±0.992
	Oe/Oa	33.89±1.022	36.13±0.986	27.70±2.342

O-HORIZON N CONCENTRATIONS

TABLE
O-HORIZON: Mean (±SE) N concentrations (% dw) in the O-horizons (n = 8)

Site	Fraction	2001	2002	2003
Haw Ridge	Oi>1yr	1.18±0.04	1.18±0.03	1.31±0.03
	Oe/Oa	1.24±0.17	1.03±0.06	1.12±0.07
Pine Ridge	Oi>1yr	1.35±0.03	1.25±0.03	1.36±0.04
	Oe/Oa	1.40±0.05	1.24±0.11	1.22±0.07
TVA	Oi>1yr	1.30±0.02	1.19±0.02	1.35±0.04
	Oe/Oa	1.27±0.06	1.19±0.05	1.33±0.07
Walker Branch	Oi>1yr	1.32±0.04	1.28±0.02	1.39±0.04
	Oe/Oa	1.23±0.03	1.39±0.05	1.09±0.10

O-HORIZON C:N RATIOS

TABLE
O-HORIZON: Mean (±SE) carbon-to-nitrogen ratios in the O-horizons (n = 8)

Site	Fraction	2000	2002	2003
Haw Ridge	Oi>1yr	40.6±0.8	41.9±1.2	33.8±0.9
	Oe/Oa	25.8±1.7	29.4±0.5	26.2±0.7
Pine Ridge	Oi>1yr	35.2±1.1	38.9±1.2	32.6±1.0
	Oe/Oa	25.7±0.6	26.2±1.7	23.3±0.6
TVA	Oi>1yr	37.3±0.5	40.6±0.5	32.1±0.9
	Oe/Oa	28.9±0.8	27.0±0.6	24.8±0.9
Walker Branch	Oi>1yr	36.1±0.9	37.9±0.7	30.8±0.8
	Oe/Oa	27.6±0.8	26.1±0.6	25.6±0.7

O-HORIZON C & N STOCKS

TABLE
O-HORIZON: Mean (±SE) O-horizon nitrogen and carbon stocks over time

Site	Year	Depth	n	g C m-2	g N m-2
Haw Ridge	2001	Oe/Oa	8	783.69±157.72	30.35±5.69
	2002	Oe/Oa	8	724.43±85.14	24.86±3.25
	2003	Oe/Oa	8	597.56±86.56	22.67±3.18
	2001	Oi>1YR	8	331.47±35.07	8.24±0.93
	2002	Oi>1YR	8	274.35±13.88	6.58±0.36
	2003	Oi>1YR	8	336.49±22.03	9.94±0.57
Pine Ridge	2001	Oe/Oa	8	592.78±62.92	23.42±2.85
	2002	Oe/Oa	8	616.04±108.70	23.74±3.74
	2003	Oe/Oa	8	485.85±32.98	20.88±1.37
	2001	Oi>1YR	8	210.19±17.39	6.02±0.58
	2002	Oi>1YR	8	228.94±30.01	5.92±0.77
	2003	Oi>1YR	8	349.52±27.50	10.76±0.86
TVA	2001	Oe/Oa	8	584.91±45.62	20.32±1.60
	2002	Oe/Oa	8	605.18±77.03	22.76±3.29
	2003	Oe/Oa	8	393.56±47.43	16.16±2.18
	2001	Oi>1YR	8	196.62±13.81	5.30±0.42
	2002	Oi>1YR	8	260.69±33.65	6.38±0.79
	2003	Oi>1YR	8	290.08±18.03	9.07±0.58
WBW	2001	Oe/Oa	8	633.67±67.76	23.33±2.85
	2002	Oe/Oa	8	471.70±50.12	18.07±1.82
	2003	Oe/Oa	8	354.96±54.35	14.05±2.32
	2001	Oi>1YR	8	264.05±23.70	7.27±0.55
	2002	Oi>1YR	8	226.33±13.79	6.01±0.44
	2003	Oi>1YR	8	361.47±11.41	11.79±0.44

REVISED SOIL DENSITIES

TABLE
SOIL: Revised mean (±SE) reference densities (g cm-3) at the four study sites

Site	00-15	15-30	30-60	60-90
HR	0.671±0.050	0.687±0.075	0.771±0.048	0.888±0.049
PR	0.533±0.056	0.735±0.038	0.819±0.025	1.014±0.036
TVA	0.577±0.032	0.681±0.043	0.647±0.047	0.833±0.090
WBW	0.716±0.043	0.684±0.056	0.739±0.019	0.823±0.059

SOIL N & C CONCENTRATIONS

TABLE
SOIL: Mean (±SE) soil N and N concentrations and C:N ratios

Site	Depth	n	[N]%	[C]%	C:N
Walker Branch	00-15	8	0.097±0.005	2.489±0.220	25.5±1.5
	15-30	8	0.017±0.002	0.589±0.051	35.6±2.6
	30-60	8	0.012±0.001	0.399±0.035	35.4±2.1
	60-90	7	0.007±0.001	0.225±0.015	39.1±4.5
Haw Ridge	00-15	8	0.057±0.0059	1.861±0.216	32.3±1.3
	15-30	8	0.012±0.0013	0.490±0.035	42.1±2.1
	30-60	8	0.008±0.0009	0.388±0.037	52.0±4.0
	60-90	8	0.006±0.0004	0.303±0.006	54.3±4.0
Pine Ridge	00-15	8	0.101±0.010	2.265±0.170	22.7±0.7
	15-30	8	0.022±0.004	0.580±0.060	29.5±3.1
	30-60	8	0.019±0.004	0.395±0.046	25.7±4.2
	60-90	6	0.013±0.003	0.322±0.042	30.4±4.5
TVA	00-15	8	0.118±0.005	2.487±0.072	21.2±0.6
	15-30	8	0.042±0.003	0.850±0.055	20.4±1.1
	30-60	8	0.022±0.003	0.475±0.030	24.3±2.7
	60-90	4	0.014±0.001	0.247±0.018	18.1±1.9

SOIL C & N STOCKS

TABLE
SOIL: Mean (±SE) soil carbon and nitrogen stocks by site and depth

Site	Depth	n	g C m-2	g N m-2
Haw Ridge	00-15	8	1816.66±165.35	56.43±5.39
	15-30	8	487.24±41.72	11.92±1.32
	30-60	8	882.30±76.70	17.86±2.30
	60-90	8	807.34±49.64	15.34±1.27
Pine Ridge	00-15	8	1798.54±204.87	79.09±8.03
	15-30	8	638.09±80.77	24.29±4.71
	30-60	8	966.59±109.95	45.22±8.71
	60-90	6	1015.94±123.44	39.02±10.35
TVA	00-15	8	2143.78±111.02	101.35±5.29
	15-30	8	854.09±47.33	42.23±2.49
	30-60	8	918.18±85.68	41.69±6.49
	60-90	4	624.41±96.27	34.02±3.06
Walker Branch	00-15	8	2629.72±192.74	104.65±8.48
	15-30	8	626.74±101.09	17.95±2.88
	30-60	8	881.35±74.23	25.64±2.57
	60-90	7	544.19±49.15	15.62±2.87

N & C IN HUMIC ACIDS & HUMIN

TABLE
HUMIC ACIDS: Nitrogen and carbon concentrations and C:N ratios in the humic acid and humin fractions isolated from surface (0–15 cm) mineral soil.

Site	Fraction	N %	C %	C:N
Haw Ridge	Humic acid	0.829 ± 0.097	16.13 ± 1.79	19.6 ± 0.8
	Humin	0.006 ± 0.002	0.60 ± 0.06	143 ± 50
Pine Ridge	Humic acid	1.066 ± 0.071	18.30 ± 1.14	17.2 ± 0.2
	Humin	0.015 ± 0.003	0.83 ± 0.08	58.0 ± 5.4
TVA	Humic acid	0.951 ± 0.059	14.95 ± 0.83	15.7 ± 0.2
	Humin	0.020 ± 0.001	1.03 ± 0.03	52.8 ± 2.8
Walker Branch	Humic acid	0.994 ± 0.060	16.85 ± 0.89	17.0 ± 0.5
	Humin	0.020 ± 0.001	0.94 ± 0.07	47.6 ± 2.5

C & N IN CHEMICAL FRACTIONS

TABLE
HUMIC ACIDS: Amounts of carbon and nitrogen in fulvic acid, humic acid, and humin fractions from a 40-g sample of mineral soil (0-15 cm).

Site	Fraction	Nitrogen (g)	Carbon (g)
Haw Ridge	Fulvic acid	0.0108±0.0014	0.2355±0.0363
	Humic acid	0.0064±0.0008	0.1258±0.0163
	Humin	0.0021±0.0006	0.2281±0.0240
Pine Ridge	Fulvic acid	0.0170±0.0003	0.2791±0.0031
	Humic acid	0.0119±0.0010	0.2053±0.0173
	Humin	0.0057±0.0012	0.3119±0.0310
TVA	Fulvic acid	0.0254±0.0016	0.4182±0.0325
	Humic acid	0.0157±0.0006	0.2462±0.0063
	Humin	0.0072±0.0003	0.3754±0.0115
Walker Branch	Fulvic acid	0.0194±0.0017	0.3757±0.0119
	Humic acid	0.0132±0.0005	0.2241±0.0066
	Humin	0.0073±0.0005	0.3467±0.0255

PERCENT N & C IN CHEMICAL FRACTIONS

TABLE
HUMIC ACIDS: Amounts of carbon and nitrogen in fulvic acid, humic acid, and humin fractions from a 40-g sample of mineral soil (0-15 cm).

Site	Fraction	Nitrogen %	Carbon %
Haw Ridge	Fulvic acid	56	40
	Humic acid	13	21
	Humin	11	39
Pine Ridge	Fulvic acid	49	35
	Humic acid	34	26
	Humin	16	39
TVA	Fulvic acid	53	40
	Humic acid	33	24
	Humin	15	36
Walker Branch	Fulvic acid	49	40
	Humic acid	33	24
	Humin	18	37