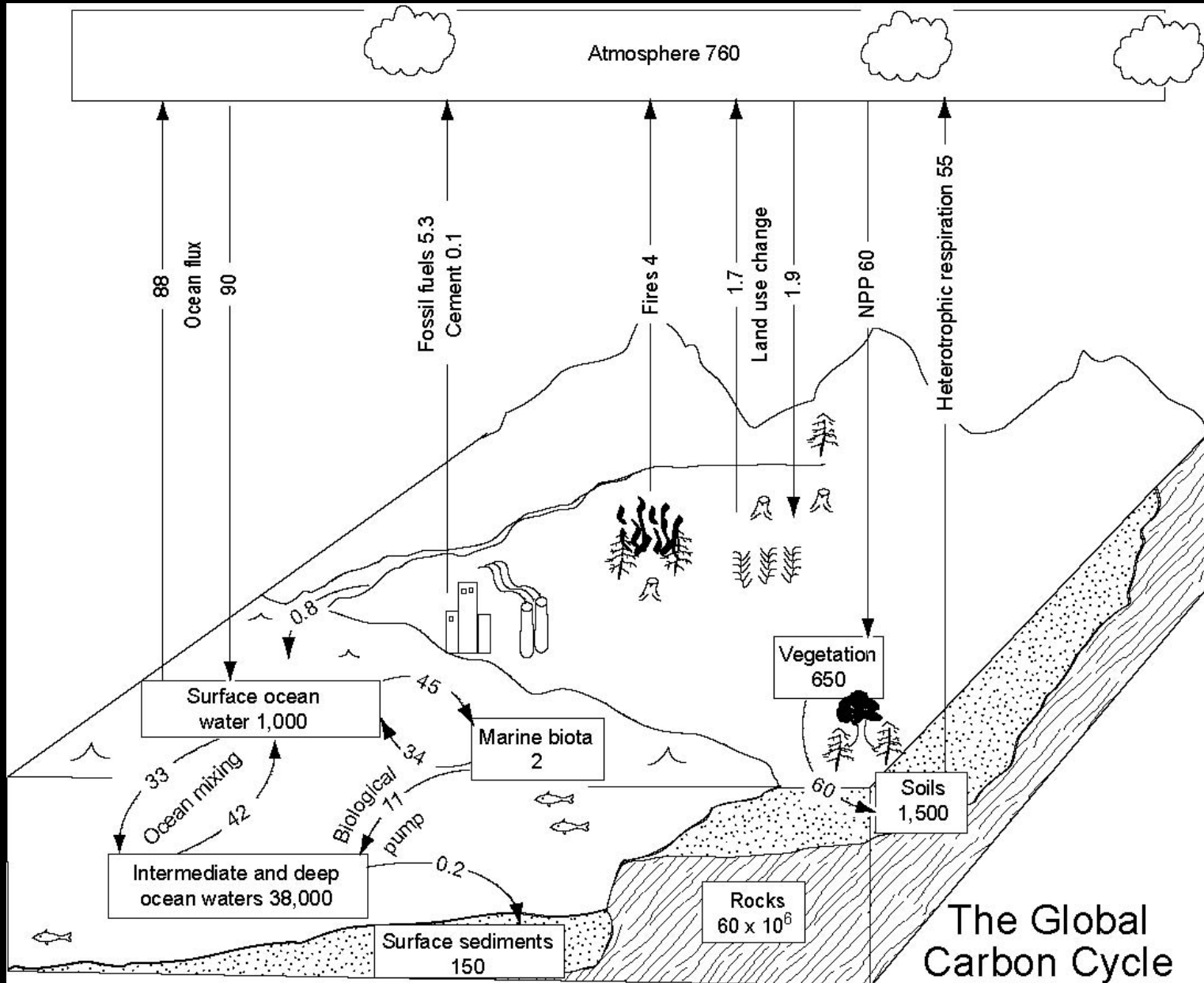


The influence of tree species composition on carbon (C) cycling in forest soils



Who cares about soil C?



From Chapin, F.S. et al. 2002. Principles of Terrestrial Ecosystem Ecology. 2002. Springer.

Where is the C?

Biome†	No. samples‡	Land area† (10 ¹² m ²)	SOC content (kg/m ²) by depth (m)				Total SOC storage (10 ¹⁵ g) by depth (m)			
			0–3	0–1	1–2	2–3	0–3	0–1	1–2	2–3
Boreal forest	648, 118	12	12.5 (8.8)	9.3 (7.0)	2.4 (2.9)	0.8 (2.1)	150	112	29	10
Crops	1271, 837	14	17.7 (12.9)	11.2 (7.7)	3.8 (4.2)	2.7 (3.4)	248	157	53	38
Deserts	285, 161	18	11.5 (8.2)	6.2 (3.4)	2.9 (3.2)	2.4 (3.4)	208	112	52	44
Sclerophyllous shrubs	62, 38	8.5	14.6 (7.9)	8.9 (3.9)	3.3 (3.0)	2.4 (2.0)	124	76	28	20
Temperate deciduous forest	60, 41	7	22.8 (13.6)	17.4 (10.8)	3.3 (3.7)	2.1 (2.4)	160	122	23	15
Temperate evergreen forest	123, 85	5	20.4 (12.0)	14.5 (8.4)	3.6 (3.7)	2.3 (2.6)	102	73	18	12
Temperate grassland	121, 83	9	19.1 (10.9)	11.7 (6.6)	4.2 (3.7)	3.2 (2.8)	172	105	38	28
Tropical deciduous forest	29, 24	7.5	29.1 (14.6)	15.8 (9.2)	7.4 (4.4)	5.8 (3.3)	218	119	56	44
Tropical evergreen forest	36, 30	17	27.9 (8.9)	18.6 (10.4)	5.4 (3.1)	3.9 (2.2)	474	316	92	66
Tropical grassland/savanna	35, 27	15	23.0 (19.9)	13.2 (8.7)	5.5 (6.1)	4.2 (5.1)	345	198	83	63
Tundra	51, 12	8	18.0 (15.2)	14.2 (14.1)	2.4 (3.1)	1.4 (2.1)	144	114	19	11
Global average	2721, 1456	121					2344	1502	491	351

Jobbagy and Jackson, 2000
Ecological Applications

Now we're in the forest, but where is the C?



TABLE 2. Northern Hemisphere carbon pools in the forest sector, 1990.

Forest C pools (Pg C)	Forested land			
	Live veg.	Dead wood	Forest floor	SOC
Canada	12.9	3.5	7.7	37.8
United States				
Alaska	0.6	†	0.5	3.7
Coterminous	12.7	†	2.6	18.9
Europe§	7.7	1.0	0.7	13.0
Russia	33.7	8.9	12.0	127.2
China	4.6	n.a.	0.9	21.0
Other§	4.7	n.a.	n.a.	n.a.
Totals	77	13	24	222

What controls the size of the soil C pool?

INPUT →

Soil organic C
(SOC)

→ OUTPUT

Dead plants, animals, microbes

Microbial Decomposition

Litter production (leaf and fine root)

Litter chemistry (leaves)

Climate / Environmental conditions

Climate / Environmental
conditions

Soil mineralogy, texture, structure

Soil mineralogy, texture,
structure

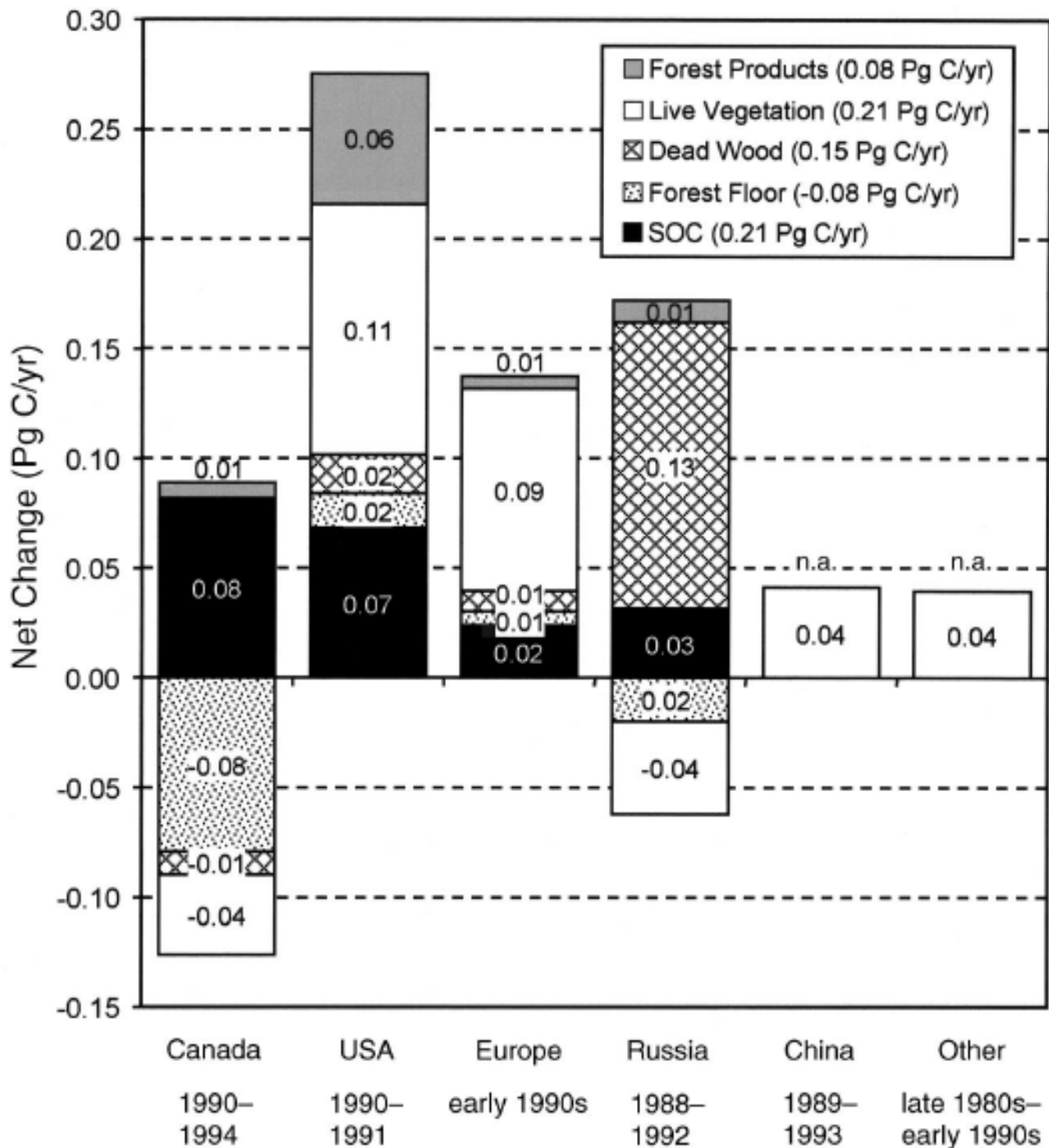
How much is SOC in forests changing?

Table 2

Comparison of stocks and fluxes for each forest carbon pool in 2005

Pool	Stocks (%)	Net change
Trees	35	49
Down dead wood	3	11
Understory	1	0
Forest floor	8	1
Forest soils	48	2
Wood products	2	10
Landfilled wood	3	27

Woodbury et al, 2007
Forest Ecology and Management



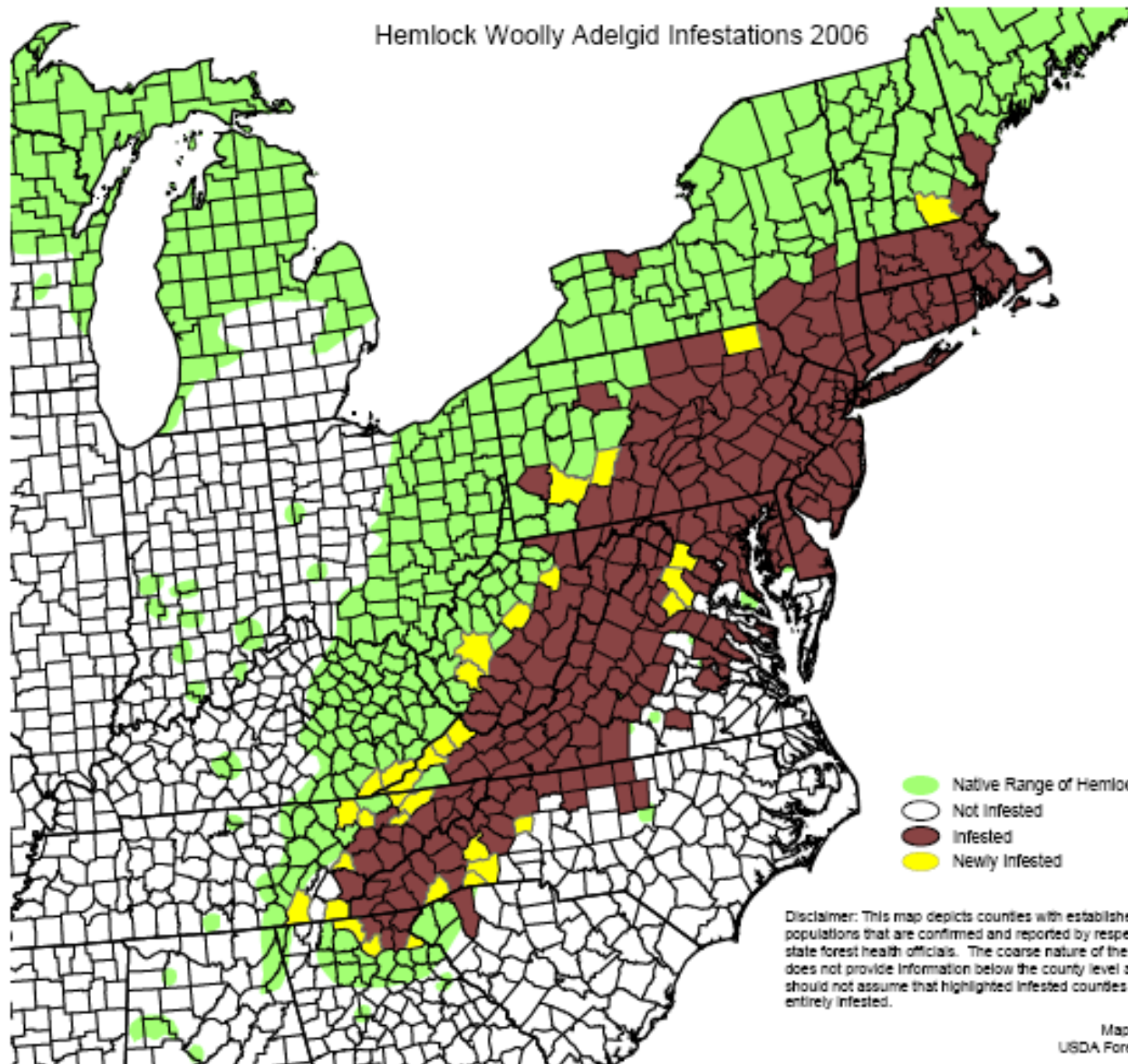
Goodale et al, 2002
Ecological Applications

Country	Fowl (1000 ha)	Soil						Trees			
		Carbon stock			Carbon sink			Carbon stock		Carbon sink	
		Tg	kg m ⁻²	Proportion of total (%) ^b	Tg yr ⁻¹	g m ⁻² yr ⁻¹	Proportion of total (%) ^b	Tg	kg m ⁻²	Tg yr ⁻¹	g m ⁻² yr ⁻¹
<i>N Europe</i>											
Denmark	452	28	6.2	54	0.2	34	24	23	5.2	0.5	108
Finland	23373	1122	4.8	65	2.0	8	28	607	2.6	5.1	22
Norway	9565	279	2.9	58	0.8	8	27	200	2.1	2.1	22
Sweden	28015	1327	4.7	59	2.5	9	17	921	3.3	12.1	43
Subtotal	61405	2757	4.5	61	5.4	9	21	1751	2.9	19.9	32
<i>NW Europe</i>											
Belgium	620	26	4.2	44	0.1	24	24	33	5.4	0.5	74
Ireland	429	5	1.3	38	0.1	30	21	9	2.1	0.5	113
Netherlands	334	13	3.8	35	0.4	107	41	24	7.1	0.5	152
UK	2380	66	2.8	43	0.8	32	31	87	3.6	1.7	71
Subtotal	3763	110	2.9	42	1.4	37	31	152	4.1	3.1	83
<i>Central Europe</i>											
Austria	3877	275	7.1	44	2.4	61	50	351	9.0	2.4	61
France	13504	469	3.5	40	4.4	33	37	700	5.2	7.5	55
Germany	10734	729	6.8	42	9.0	84	49	993	9.3	9.4	88
Switzerland	1186	119	10.0	46	0.5	43	61	140	11.8	0.3	27
Subtotal	29301	1592	5.4	42	16.2	55	45	2183	7.5	19.6	67
<i>S Europe</i>											
Greece	6123	50	0.8	43	0.1	1	70	67	1.1	0.0	1
Italy	8550	171	2.0	31	2.6	31	31	386	4.5	6.0	70
Portugal	3102	70	2.3	47	0.2	5	40	78	2.5	0.2	8
Spain	25622	191	0.7	47	0.0	0	0	214	0.8	5.5	22
Subtotal	43397	482	1.1	39	2.9	7	20	745	1.7	11.8	27
Total	137866	4940	3.6	51	25.9	19	32	4833	3.5	54.4	39

The trees are changing . . .

Region, location	Presettlement white oak (percentage)	Present-day dominants (percentage)
Northeast		
Massachusetts		
Connecticut Valley	45	Maple (30), oak^a (22) , hemlock (15), pine (11), birch (11)
Pellham Hills	38	Maple (27), oak^a (21) , hemlock (15), birch (15), pine (11)
Central uplands	21	Maple (24), oak^a (23) , pine (16), birch (12), hemlock (12)
Eastern lowlands	59	Oak^a (35) , maple (23), pine (21), birch (8)
Central Massachusetts	27	White pine (23), black oak (21), red oak (19), white oak (9)
Eastern New York	36	Maple (30), chestnut oak (14), red oak (10), pine (9), white oak (4)
Mid-Atlantic		
Central Pennsylvania		
Allegheny Mountains	19	Red maple (35), white oak (19) , red oak (11), chestnut oak (9)
Ridge and Valley region	21	Chestnut oak (28), red maple (14), red oak (14), white oak (13)
Valleys	41	White oak (43) , red maple (15), black cherry (10), pine (7)
Ridges	11	Chestnut oak (43), red oak (19), red maple (14), white oak (1)
Northwest Pennsylvania	21	Red maple (22), black cherry (14), hemlock (7), white oak (3)
Southeast Pennsylvania	30	Chestnut oak (26), red maple (18), black oak (15), white oak (4)
Southeast Pennsylvania	33	Box elder (23), red maple (19), ash (8), elm (7), white oak (1)

Hemlock Woolly Adelgid Infestations 2006

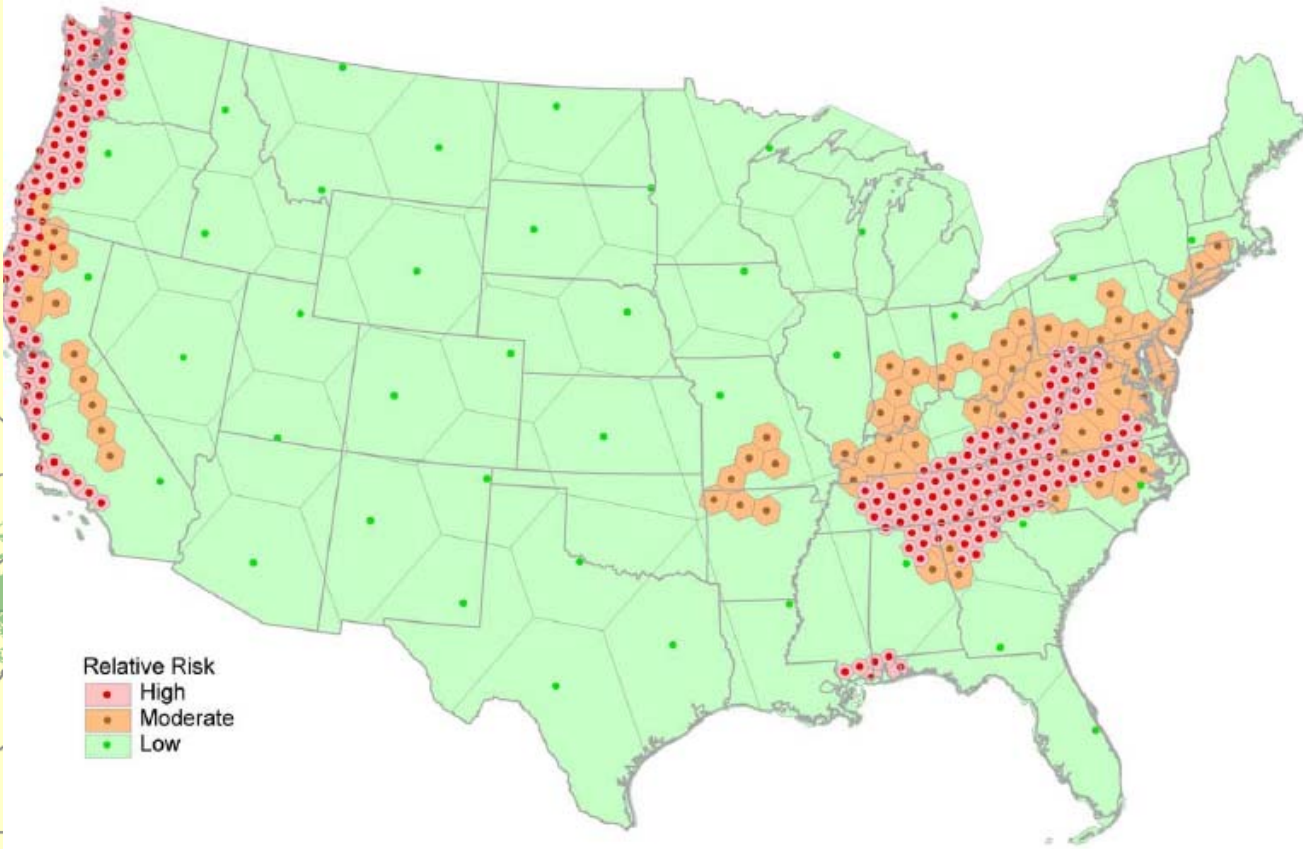


Disclaimer: This map depicts counties with established HWA populations that are confirmed and reported by respective state forest health officials. The coarse nature of the map does not provide information below the county level and users should not assume that highlighted infested counties are entirely infested.



Map Produced by:
USDA Forest Service 2/7/2007

Distribution of Sudden Oak Death as of December 20, 2006



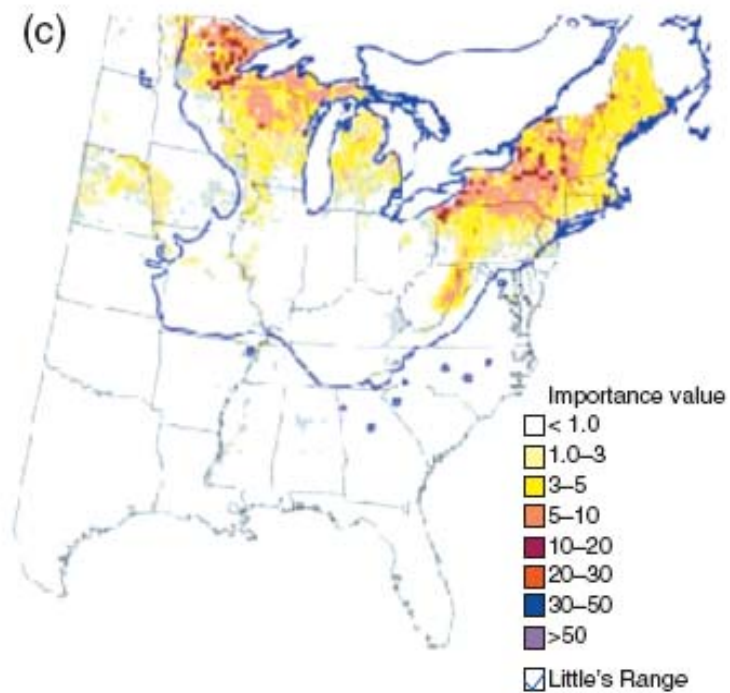
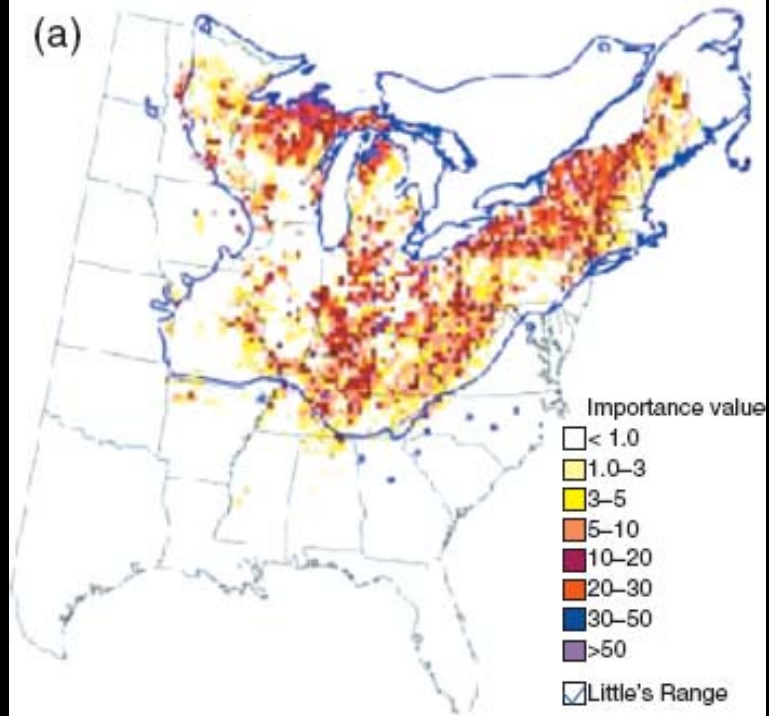
- # Confirmed isolation of *Phytophthora ramorum* *
- Host species for *Phytophthora ramorum* **
- Counties with *Phytophthora ramorum* confirmed in wildland

* Data provided by CDFA and UC Davis/UC Berkeley pathologists
 ** California host data from CAL GAP Analysis Project. Oregon host data from OR GAP Analysis Project. Data has been queried to only show the geographic range for species that are hosts for *Phytophthora ramorum*.

NOTES:
 1. Sampling is occurring throughout the state.
 2. Nursery confirmations are not depicted.

↑ US Forest Service

← California Oak Mortality Task Force

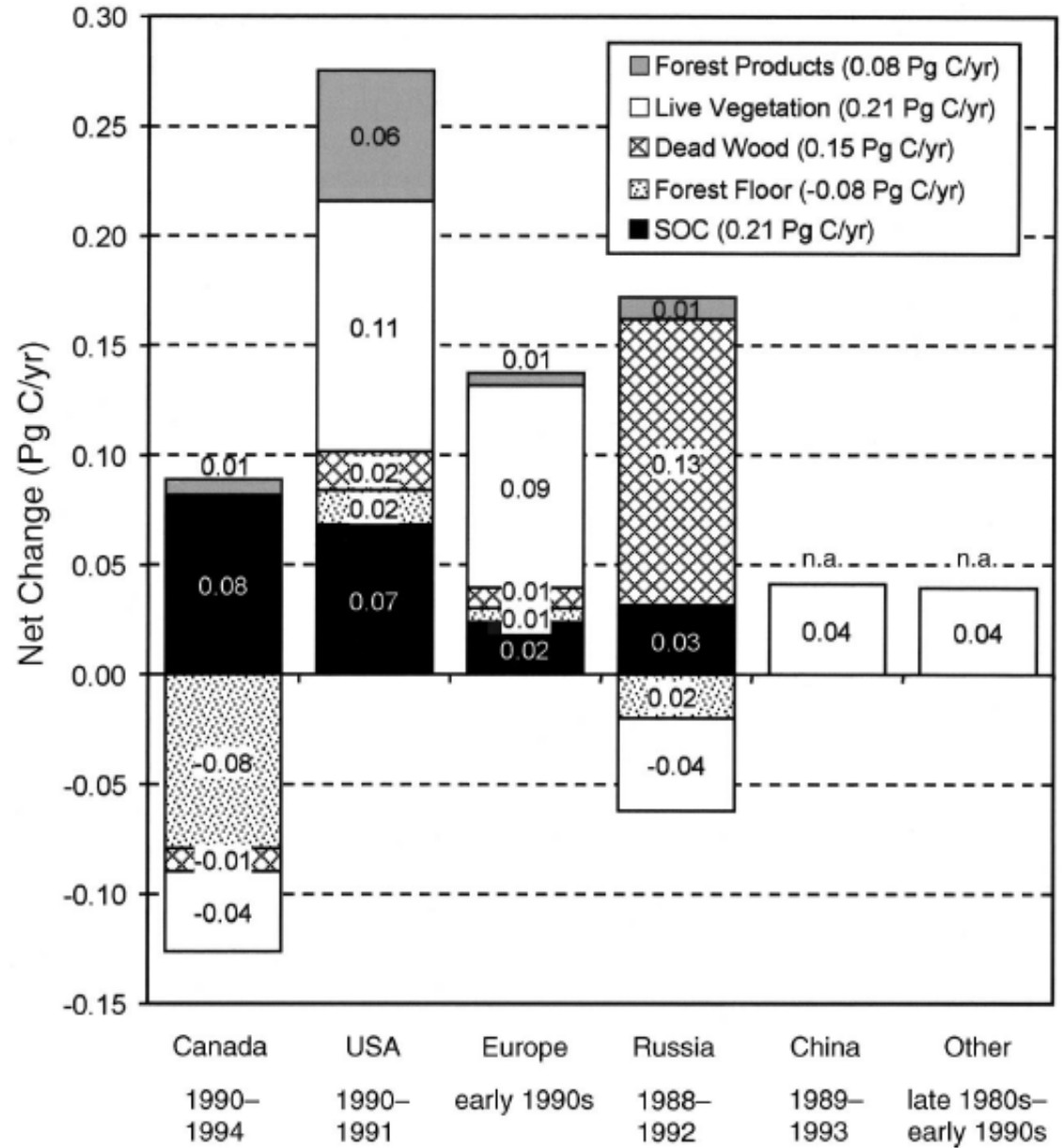


Lovett and Mitchell 2004
Frontiers in Ecology and the Environment

Table 2
Comparison of stocks and fluxes for each forest carbon pool in 2005

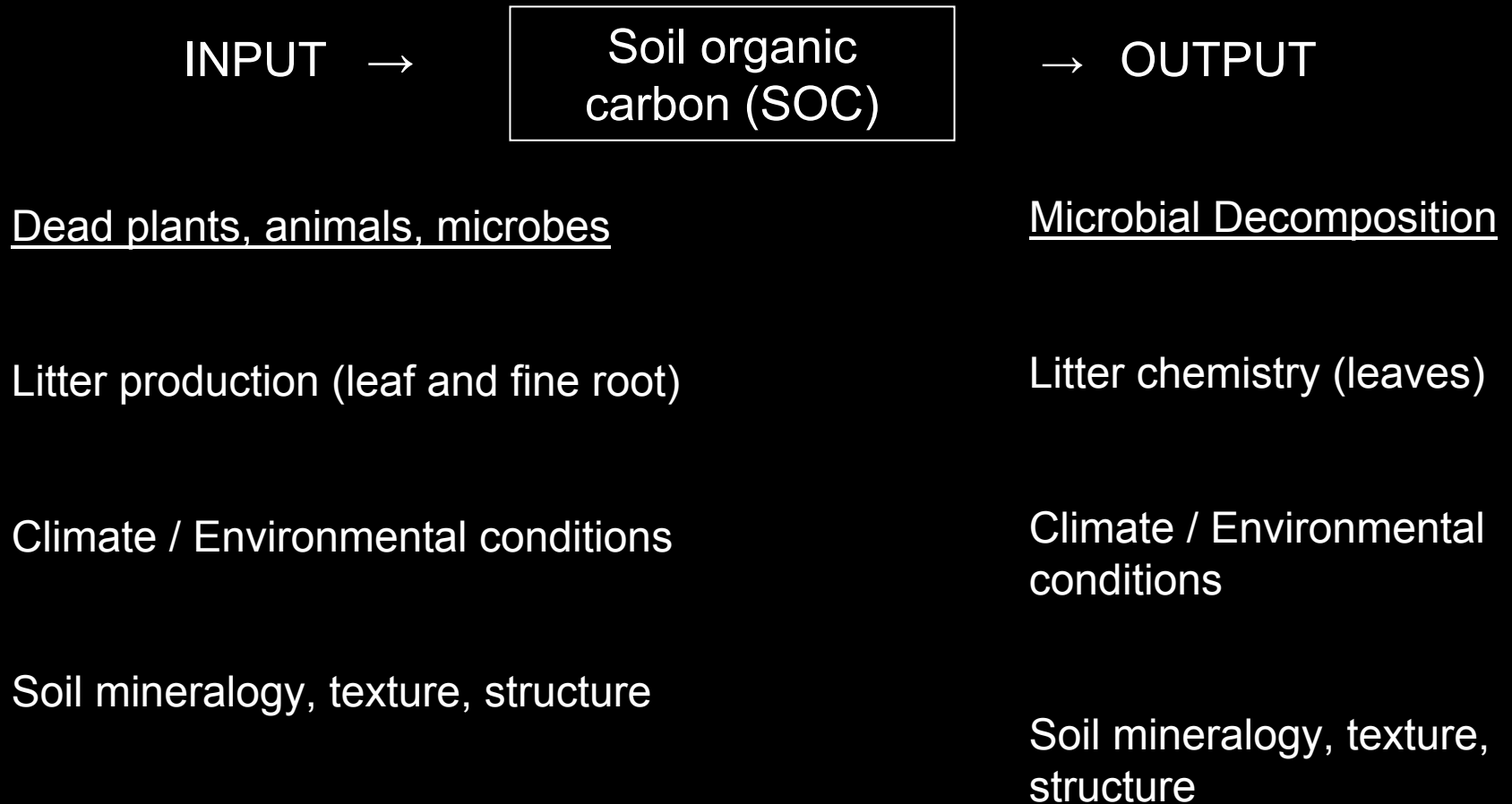
Pool	Stocks (Gt)
Trees	35
Down dead wood	3
Understory	1
Forest floor	8
Forest soils	48
Wood products	2
Landfilled wood	3

Woodbury et al, 2007
Forest Ecology and Management



Goodale et al, 2002
Ecological Applications

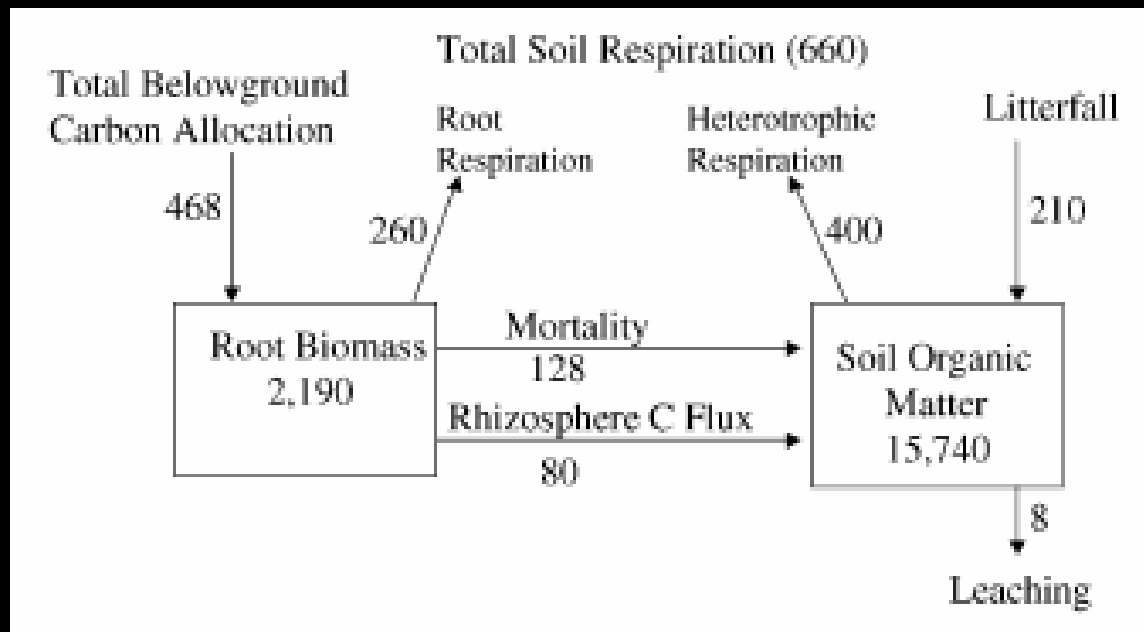
What controls the size of the SOC pool?



What are we doing?

How do different tree species influence C cycling in soil?

How does variation in leaf and fine root traits of tree species influence soil C cycling?

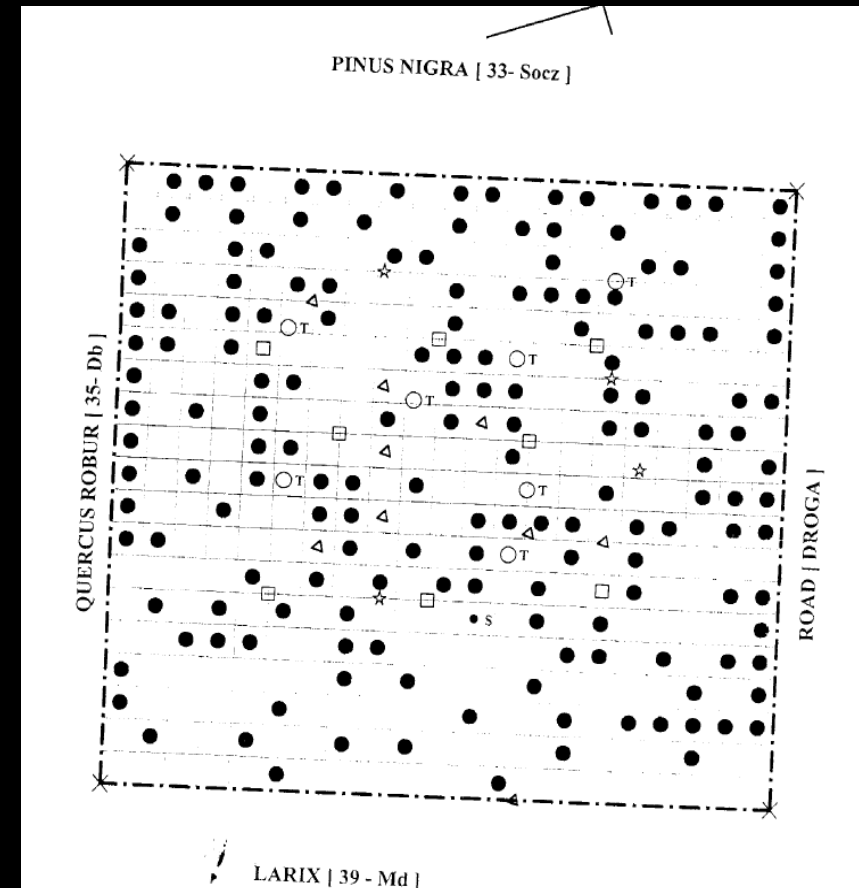


Study site



Experimental design

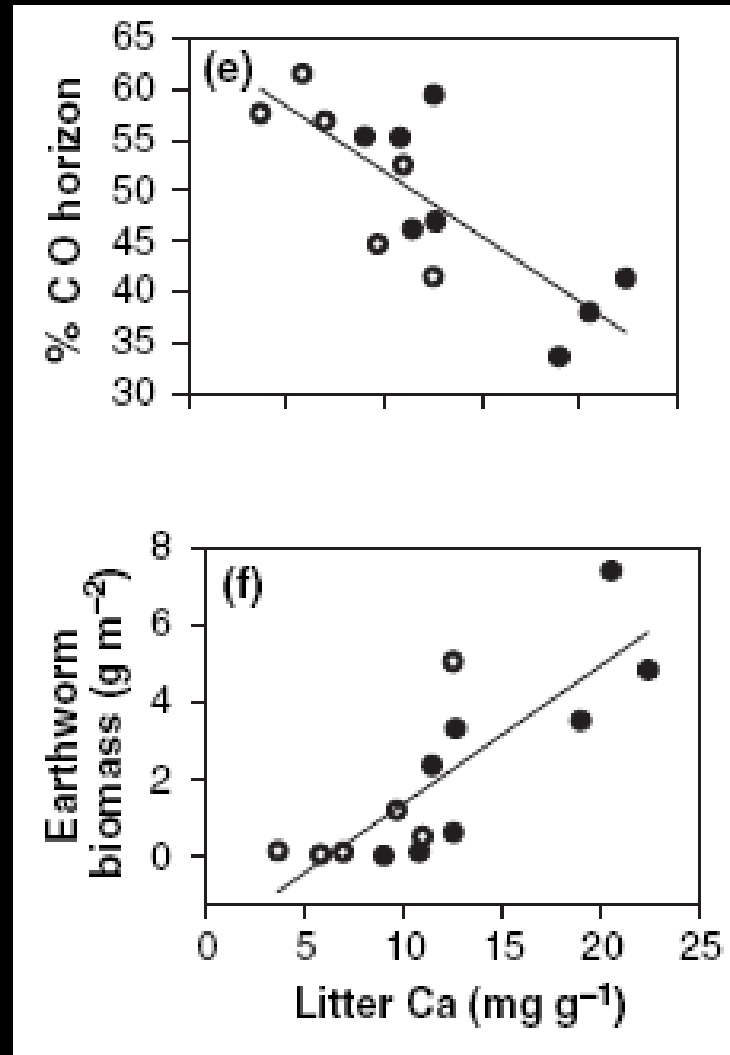
Ac ps	Pi ab	Qu ro	1	2	3
Ac pl	Fa sy	Ps me	6	5	4
Ti co	Ab al	La de	7	8	9
Pi ab	Qu ro	Ac ps	12	11	10
Fa sy	Ps me	Ac pl	13	14	15
Ab al	La de	Ti co	18	17	16
Qu ro	Ac ps	Pi ab	19	20	21
Ps me	Ac pl	Fa sy	24	23	22
La de	Ti co	Ab al	25	26	27
30	29	28	La de	Ca be	Be pe
31	32	33	Pi ab	Qu ru	Pi ni
36	35	34	Ps me	Qu ro	Pi sy
37	38	39	Ca be	Be pe	La de
42	41	40	Qu ru	Pi ni	Pi ab
43	44	45	Qu ro	Pi sy	Ps me
48	47	46	Be pe	La de	Ca be
49	50	51	Pi ni	Pi ab	Qu ru
54	53	52	Pi sy	Ps me	Qu ro



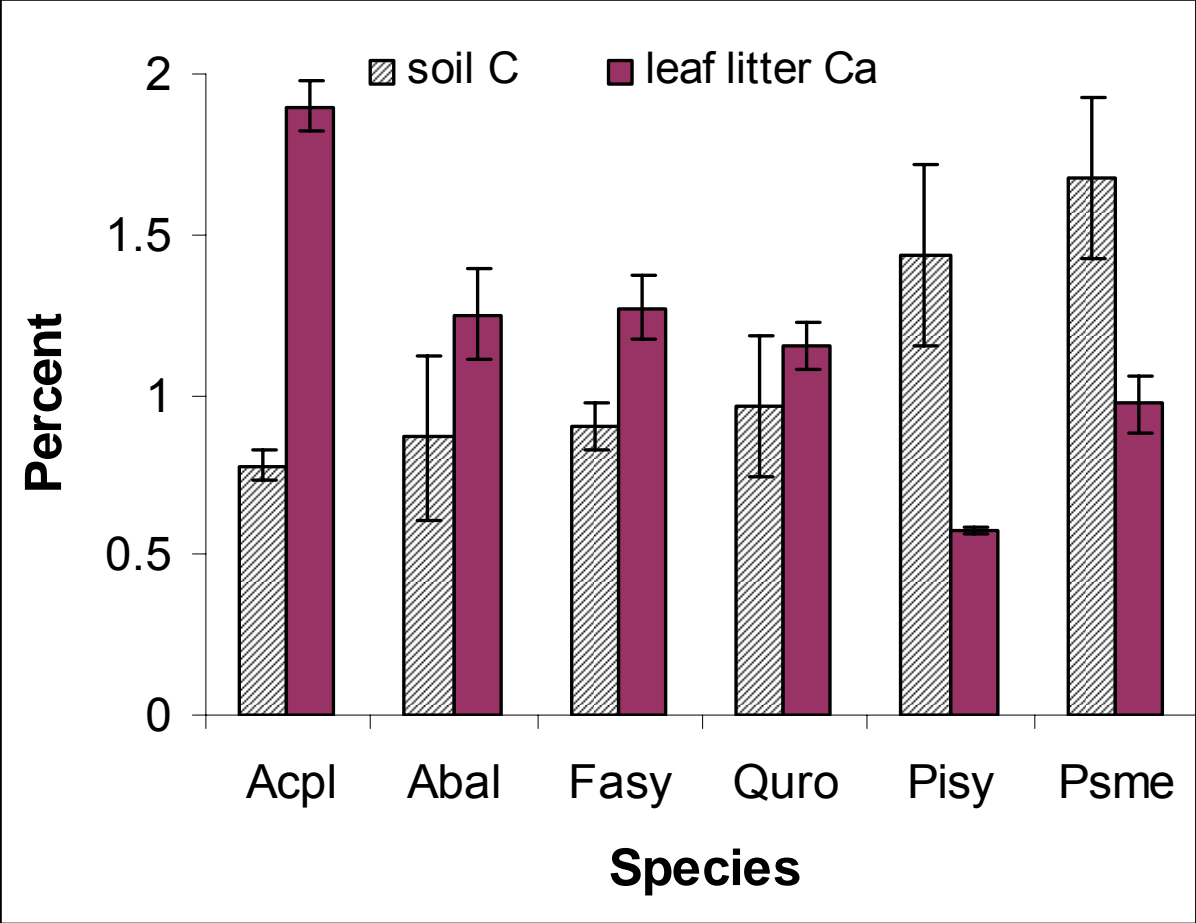
Species	Leaf litter production‡ (kg ha ⁻¹ yr ⁻¹)	Root production† (cm yr ⁻¹)	Leaf litter N‡ (mg g ⁻¹)	Leaf litter Ca‡ (mg g ⁻¹)	Leaf litter lignin‡ (mg g ⁻¹)
<i>Abies alba</i>	802	20.9	12.5	12.5	304
<i>Acer platanoides</i>	2801	127.1	6.5	19	124
<i>Acer pseudoplatanus</i>	3715	86.8	9.4	20.5	164
<i>Betula pendula</i>	2559	NA	12.6	12.6	384
<i>Carpinus betulus</i>	1662	NA	11	9	140
<i>Fagus sylvatica</i>	3091	33.3	8.4	12.7	242
<i>Larix decidua</i>	1293	18.4	8.7	7	316
<i>Picea abies</i>	1845	31.1	9.9	11	213
<i>Pinus nigra</i>	2794	38	5.4	3.7	238
<i>Pinus sylvestris</i>	3293	25.2	6.8	5.8	176
<i>Pseudotsuga menziesii</i>	1181	2.9	7.2	9.7	246
<i>Quercus robur</i>	2237	22.1	12.7	11.5	230
<i>Quercus rubra</i>	5595	NA	7.1	10.8	196
<i>Tilia cordata</i>	2901	42.1	12.2	22.4	375

‡from Reich et al. 2005 †from Withington et al. 2006

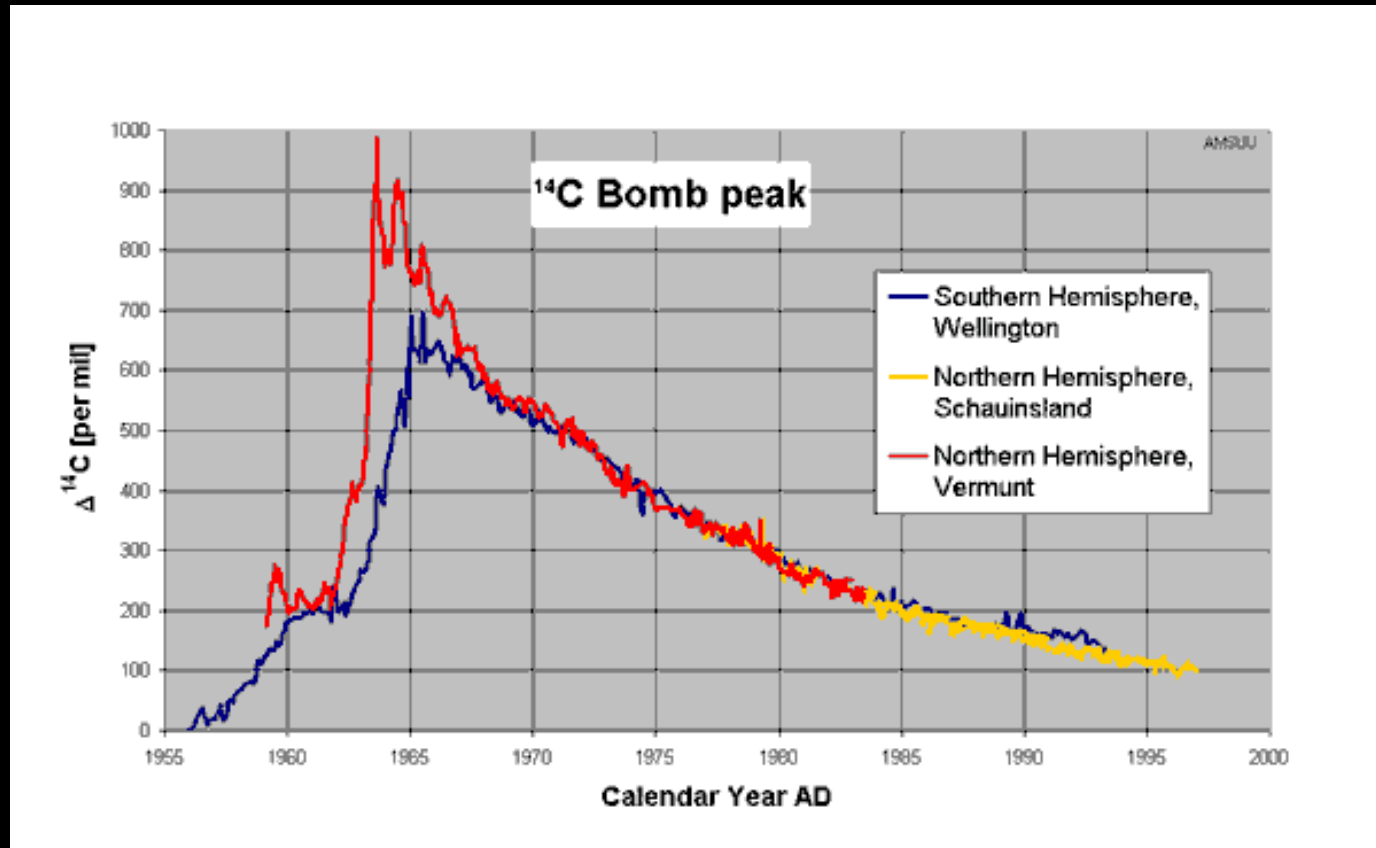
Organic horizon

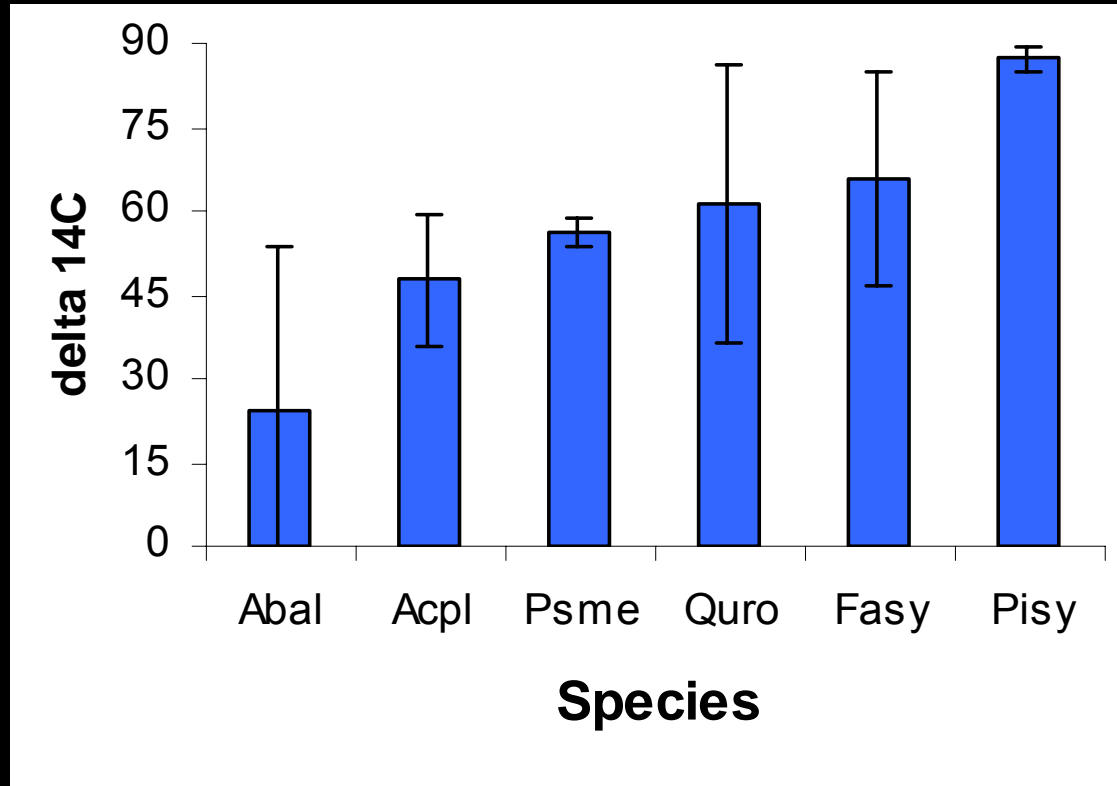


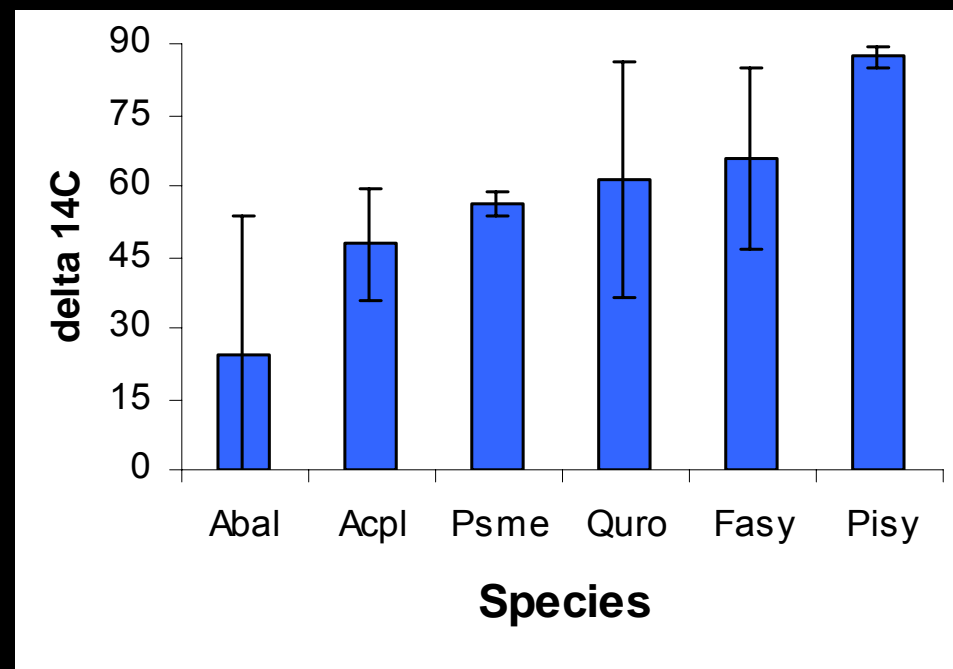
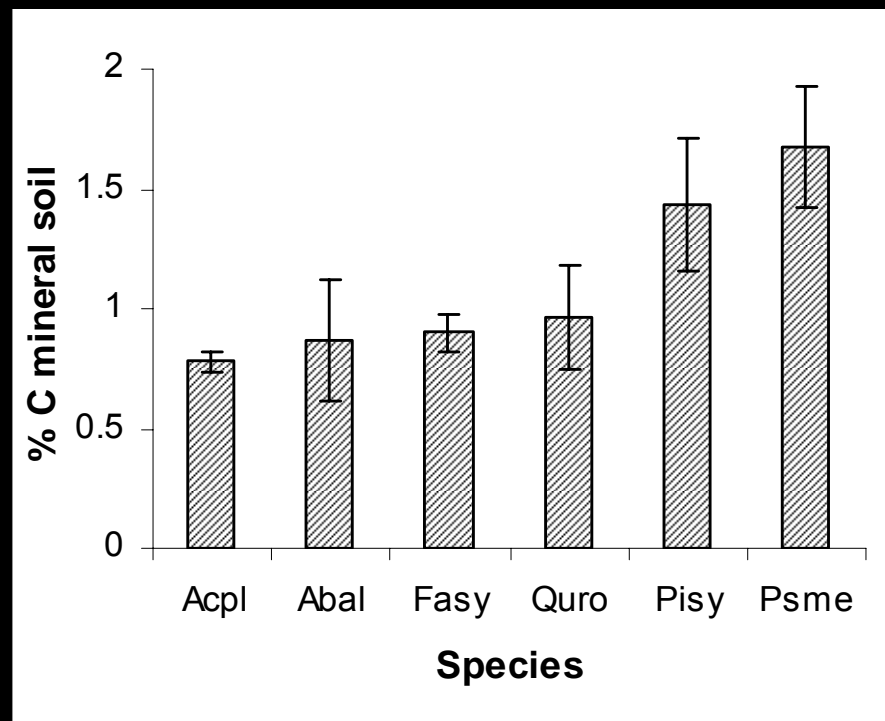
Mineral soil



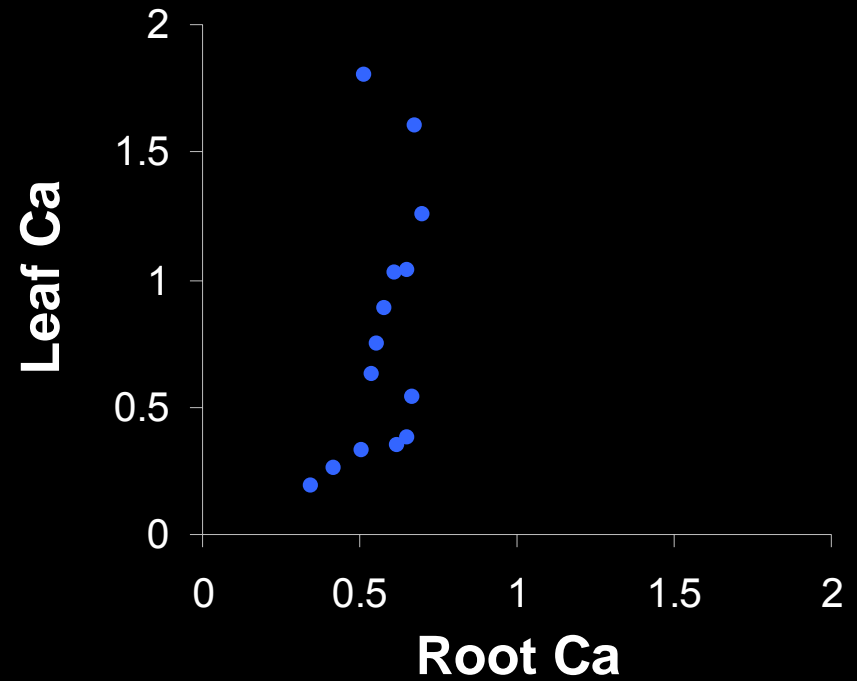
Radiocarbon







What else are we missing?



Unpublished data, Reich et al.

Thanks

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