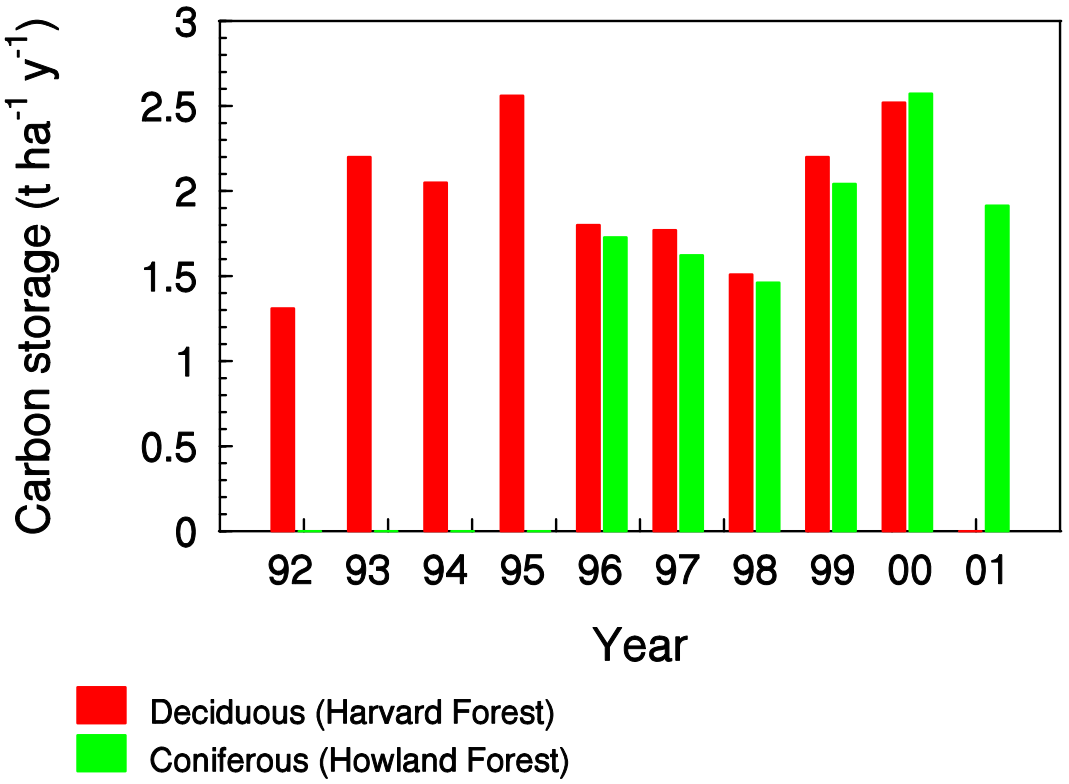
Contribution of northern hemisphere forests to carbon budgets

Atmospheric inversions indicate the N. Hemisphere is accumulating carbon (Gurney et al. 2002)

Annual net ecosystem C exchange by eddy covariance at 2 Ameriflux sites



(Deciduous forest data courtesy S. Wofsy)

Forest area of New England

(acres)

State	Total Land Area	Total Forest Land	Timberland	Productive/ Reserved
CT	3,101,000	1,819,000	1,768,000	21,000
ME	19,753,000	17,533,000	16,987,000	278,000
MA	5,016,000	3,203,000	2,960,000	101,000
NH	5,740,000	4,981,000	4,760,000	74,000
RI	669,000	401,000	371,000	8,000
VT	5,920,000	4,538,000	4,429,000	64,000
Total	40,199,000	32,475,000	31,275,000	546,000

Forest management effects on carbon sequestration at Howland Forest, Maine, USA.

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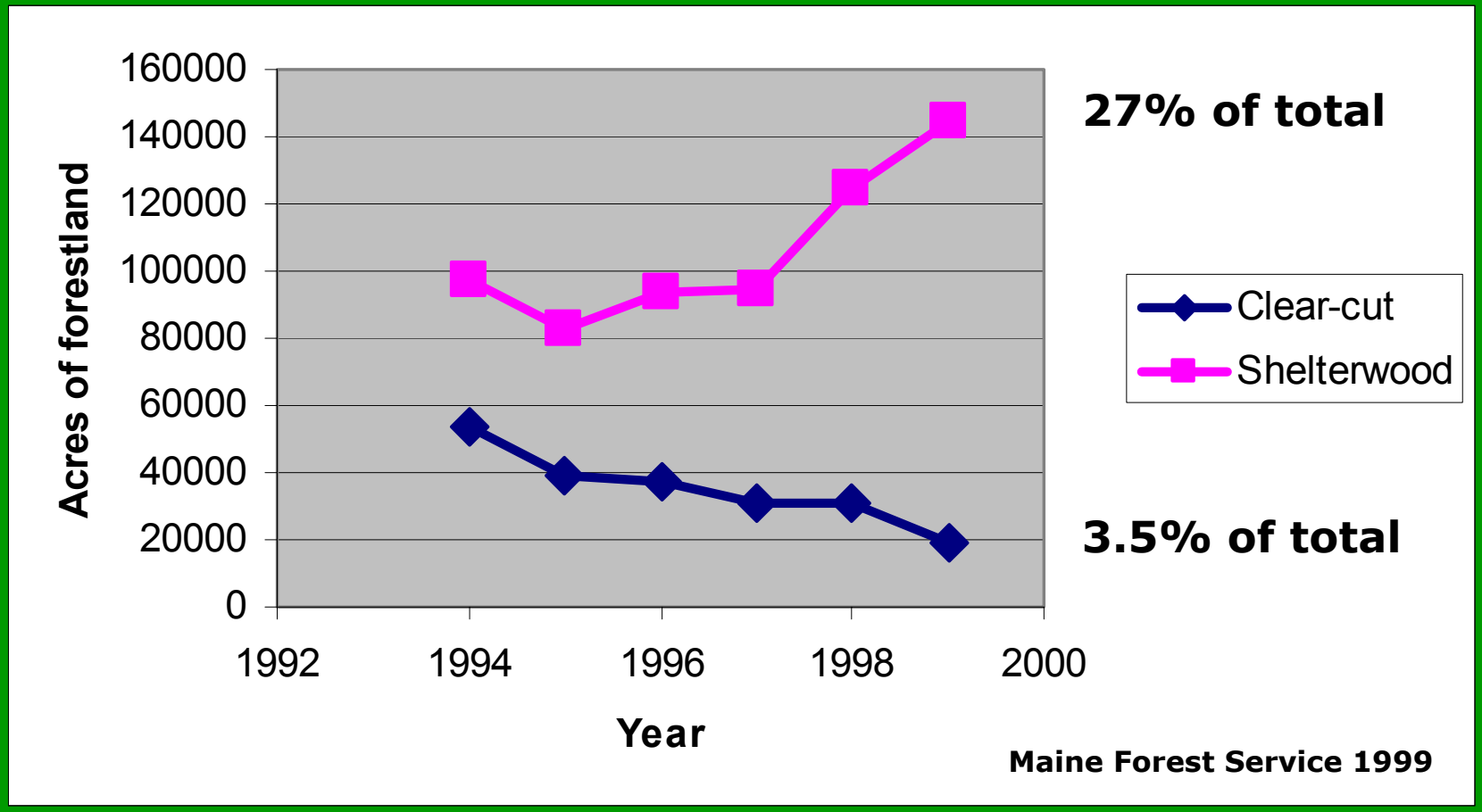
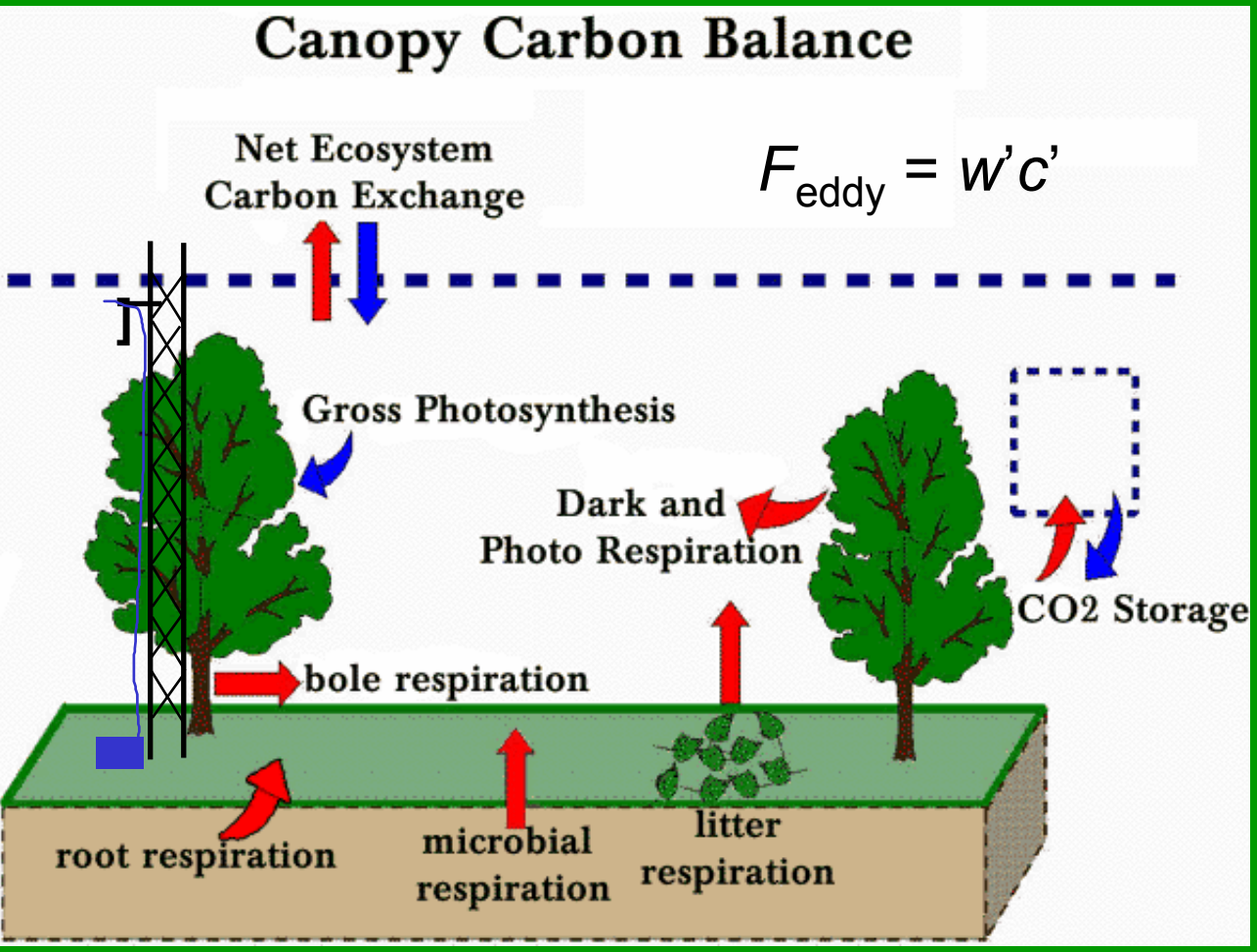
Changes in forest management practices in Maine (1994-1999)



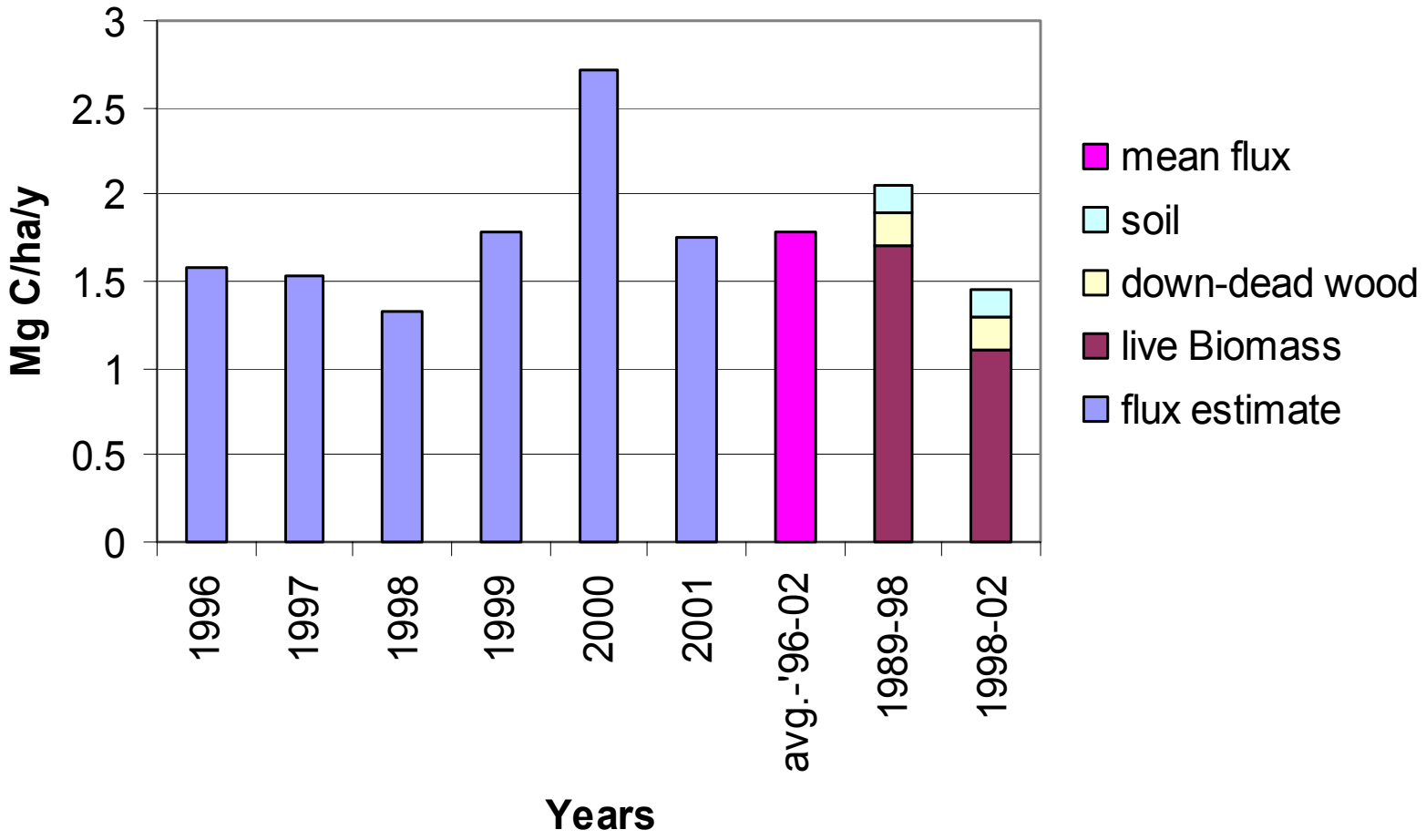
Total harvested area in 1999: 536,219 acres (6% increase from 1994)

Measuring forest carbon balance
(eddy covariance)



How are the carbon pools changing?

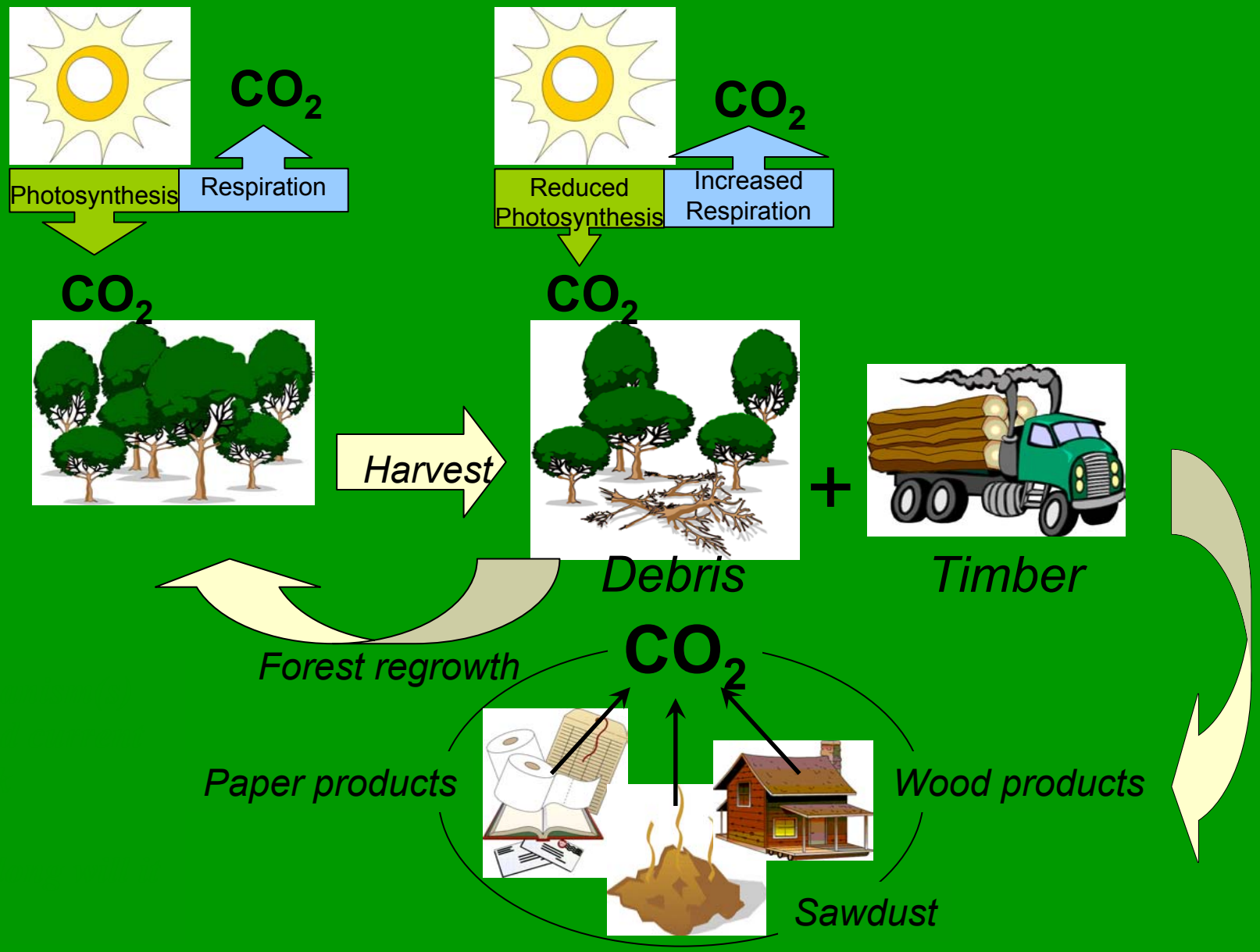
Annual NEE=1.8 (0.4) Mg C/ha/y



Shelterwood harvest

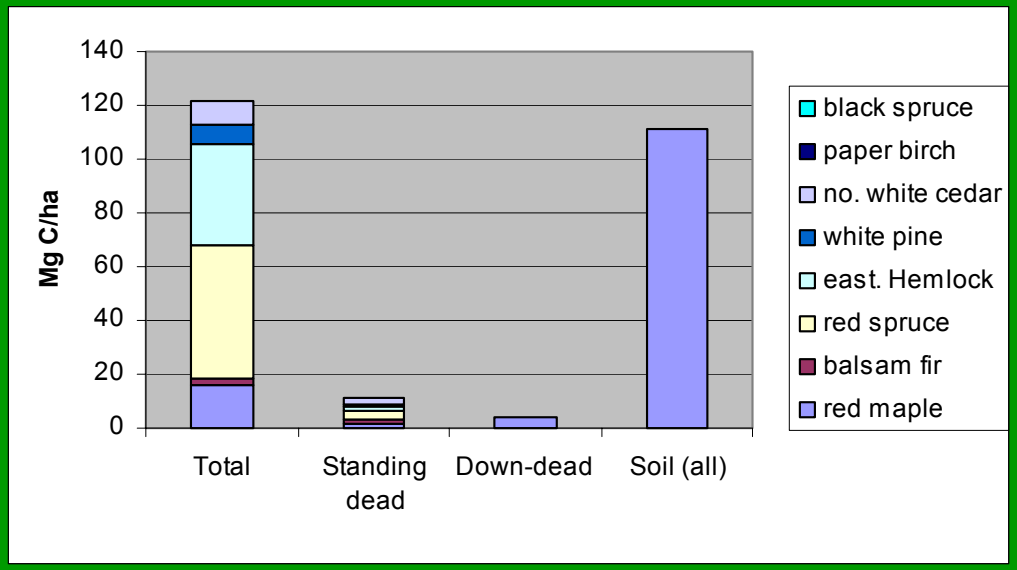
Carbon consequences of shelterwood harvest

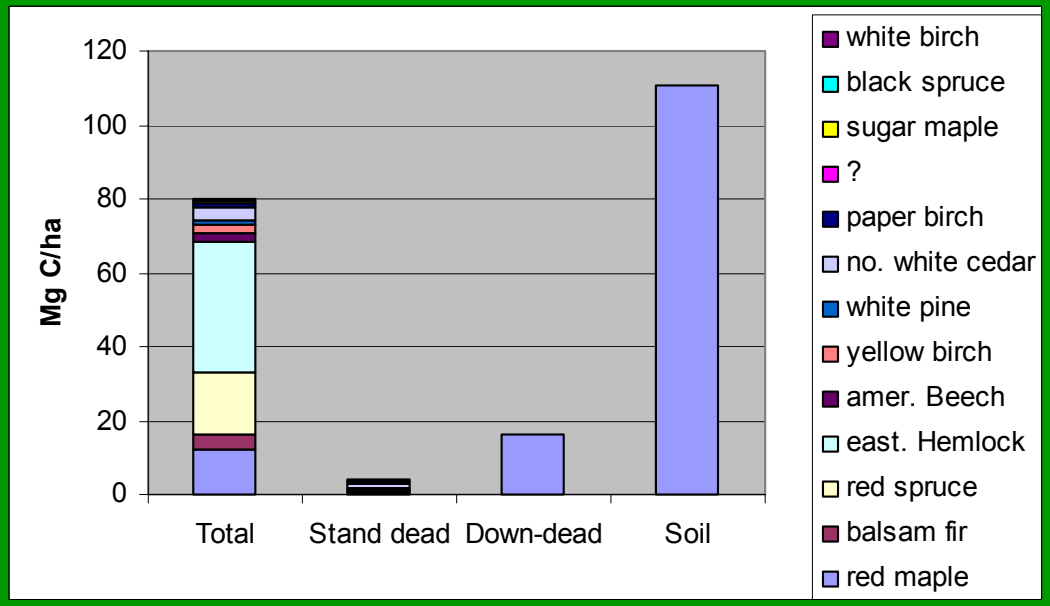
Large areas of managed forest in the US



Carbon pools, pre-harvest

Control tower site

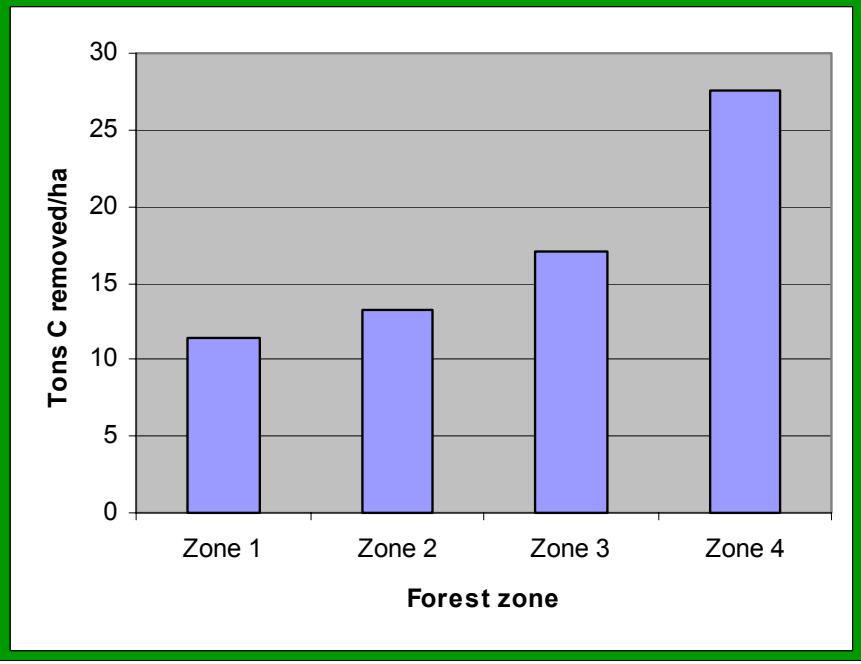


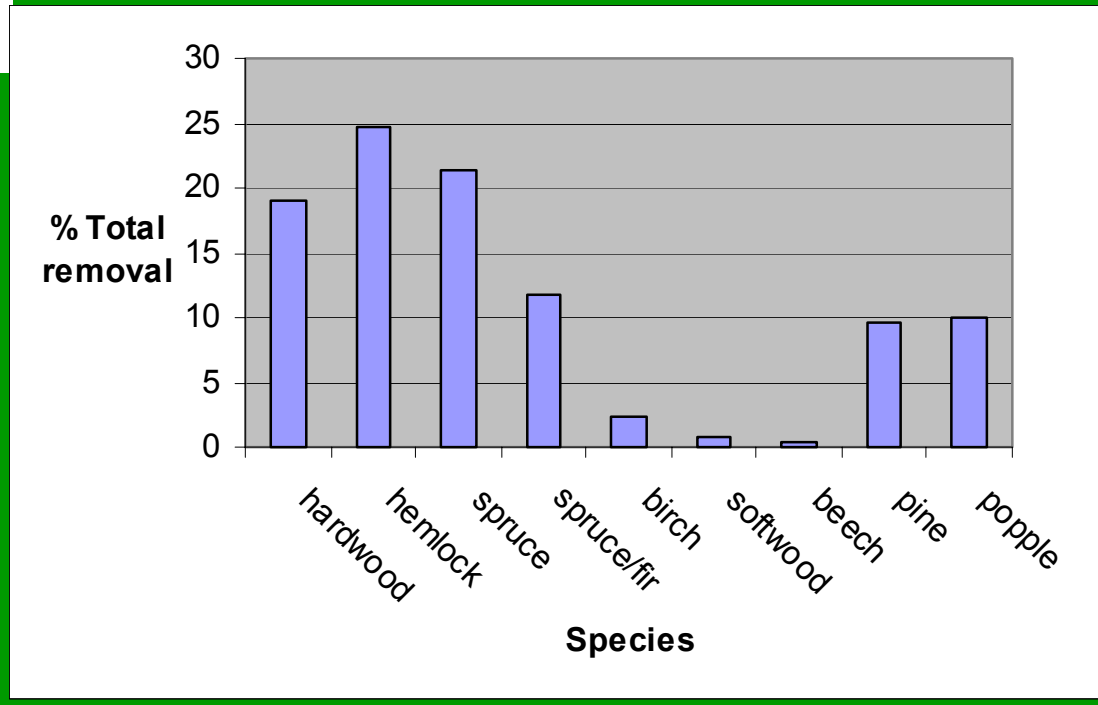


Harvest tower site

Harvest removals

Timber

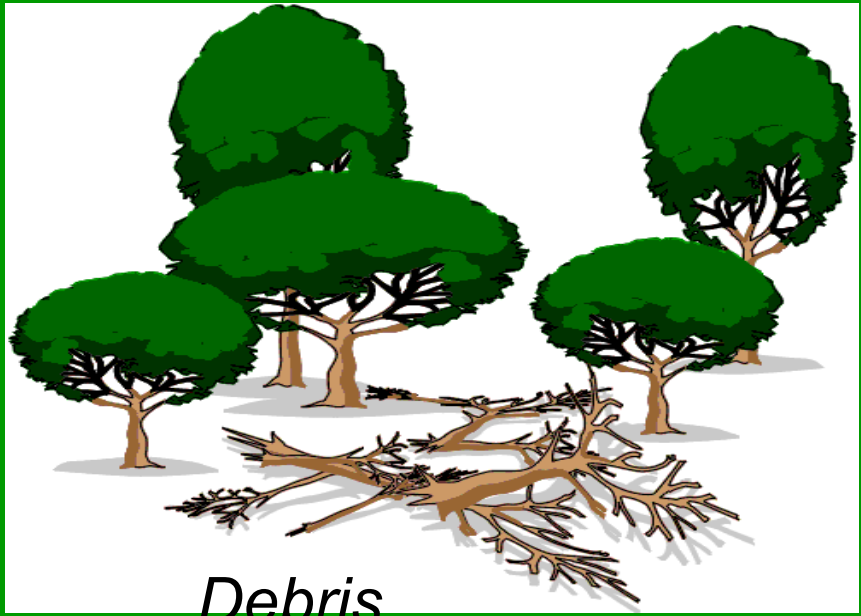




Truck-based estimate
19 t C/ha removed

Plot re-survey estimate
15.0 (SE=2) t C/ha removed

Slash production at harvest – down dead wood

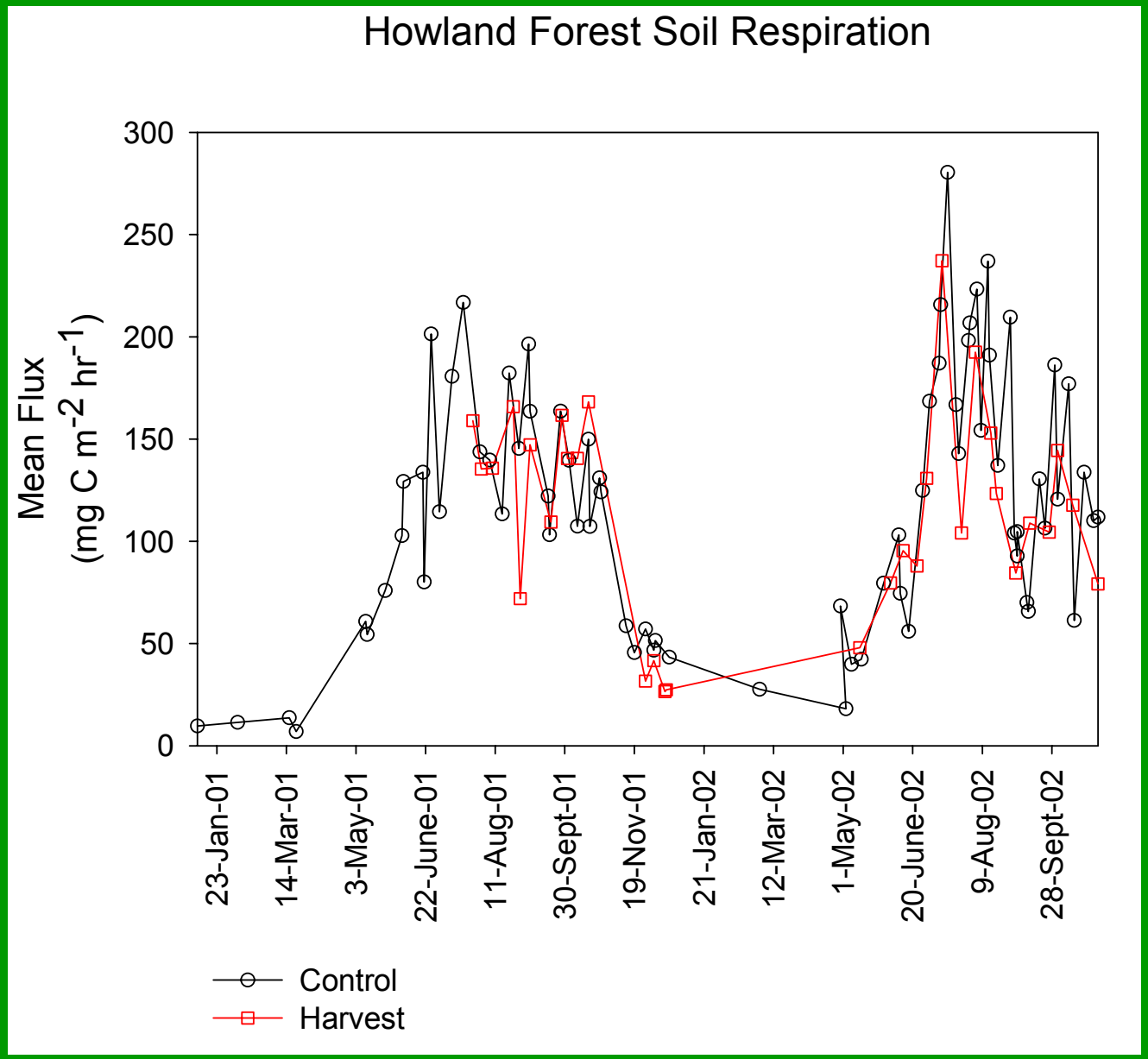


<u>Remeasurement of cleared plots:</u>
4.5 (6) t C/ha (n=11) (aboveground)

<u>Estimates based on tree allometry</u>
2.9 (2.4) t C/ha branches (n=34)
2.2 (2.0) t C/ha foliage
4.7 (3.7) t C/ha stump/roots

<u>Estimates based on paths (n=6)</u>
5.3 t C/ha branches and foliage

Soil respiration in harvested and control stands



$Rsoil = R_h + R_a$

R_a lower after harvest?
R_h higher after harvest?

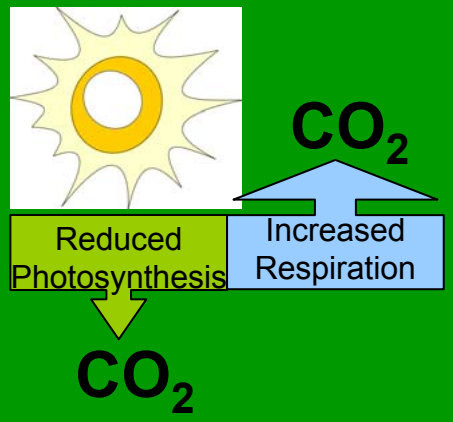
No change in soil temperature or moisture in surface soils

No difference in soil respiration

Soil C change?

Impact of harvest on net carbon exchange

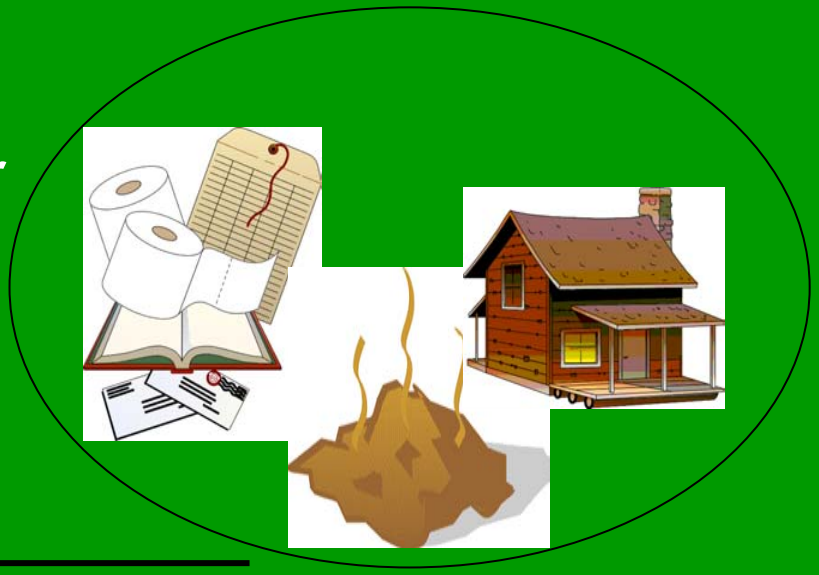
Summer 2002 Ecosystem Exchange Characteristics	Control Tower $\mu mol\ m^{-2}\ s^{-1}$ (mean ± std dev, n)	Harvest Tower $\mu mol\ m^{-2}\ s^{-1}$ (mean ± std dev, n)
Daytime uptake	-9.3 ± 5.1, n=502	-5.9 ± 5.7, n=490
Nocturnal respiration	5.5 ± 4.0, n=497	3.0 ± 4.8, n=506



<u>Initial predictions</u>
Decreased uptake
No increase in respiration

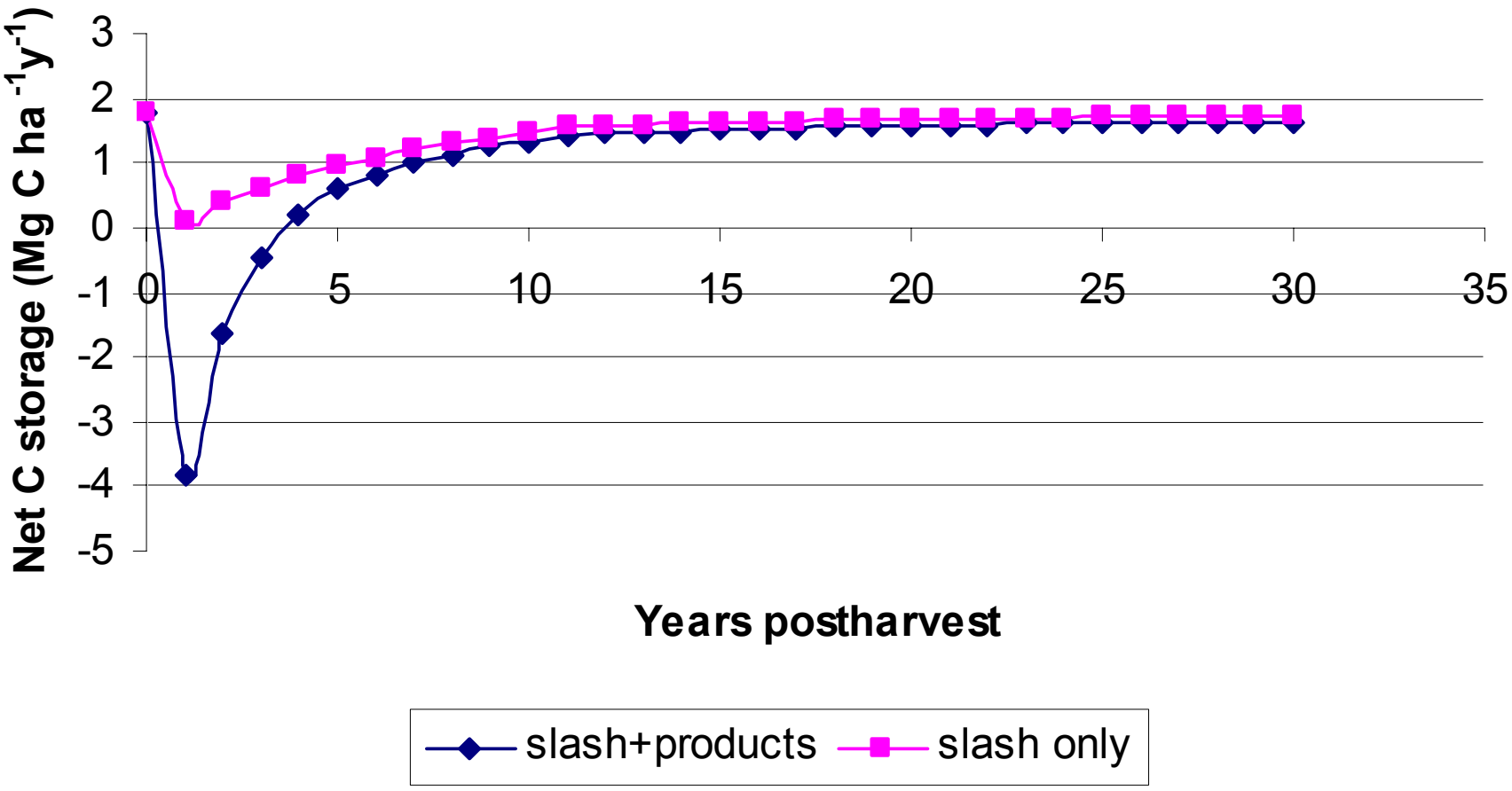
Fate of harvested wood

Wood products produced, and their longevity, affects the net C balance of the shelterwood harvest regime

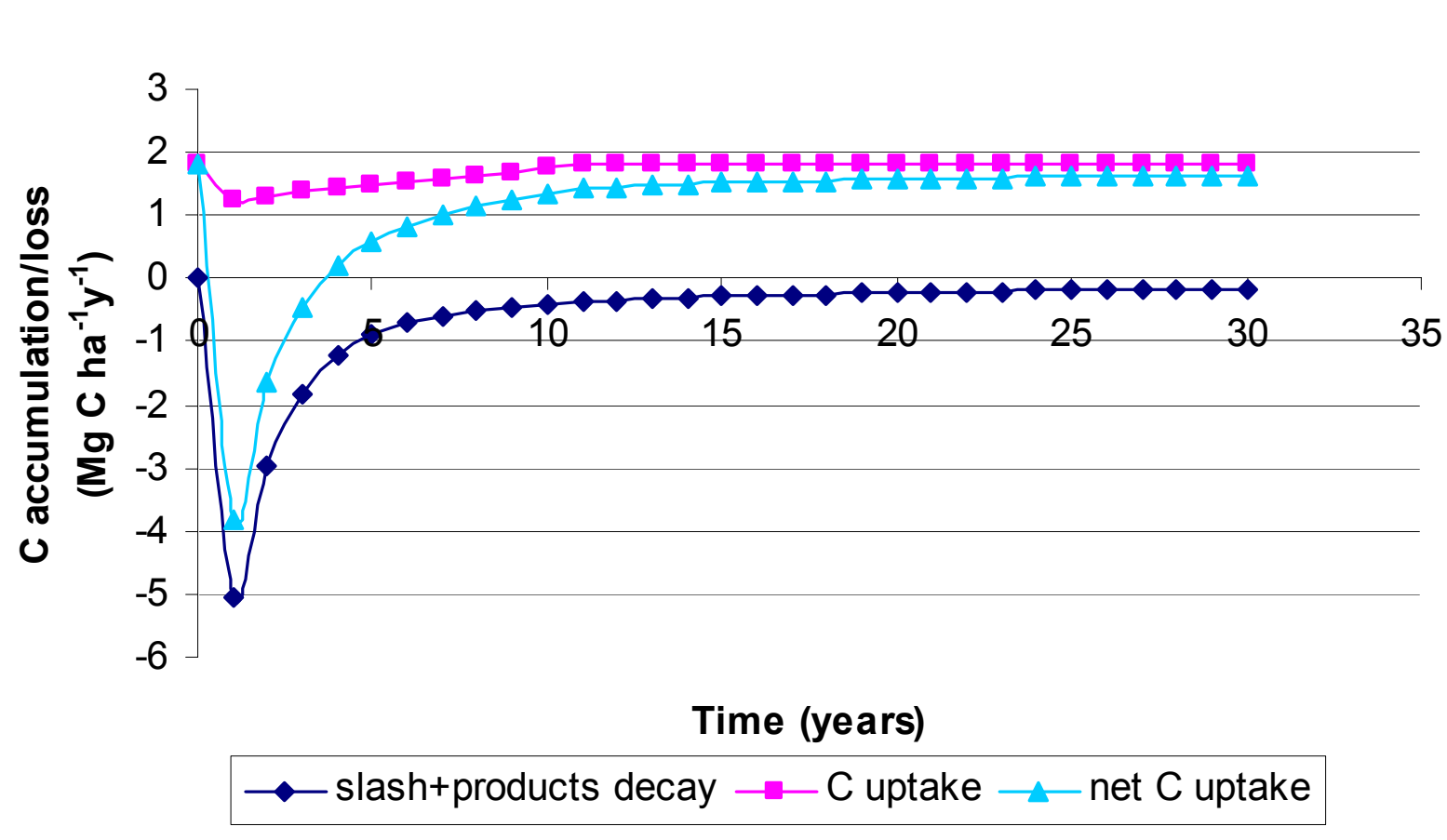


Product	Wet mass (tons)	% total	Half-life (y)
Boltwood	232	2	17
Chipwood	364	3	1
Groundwood	199	2	1
Logs	4771	40	35
Pulp	4265	36	1
Studs	463	4	35
‘Tree length’	1511	13	1

Simulated carbon losses following harvest
(with and without wood products)



Simulated changes in net carbon balance
(with wood products)



No harvest:	54 t C/ha for 30y
With harvest, assuming 1.8 t C/ha/y net uptake:	34 t C/ha for 30 y
With harvest, assuming 20% increase in net uptake:	63 t C/ha for 30 y

Conclusions

Mature, relatively undisturbed forests at Howland, Maine sequester about 1.8 Mg C ha^{-1} y^{-1}, primarily in vegetation

Shelterwood harvest removes about 30% of stand biomass, and creates slash containing 8-10 Mg C ha^{-1}

A large portion of the harvested wood goes to paper products, so C storage in wood products will be relatively small

Initial results indicate that net C uptake has decreased slightly. Over 30 years, about a 15% increase in net uptake is required to exceed net uptake in control stand

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