Linking extensive monitoring systems for complete C balance estimation: A pilot test in the Catskill Mountains, NY (USA)

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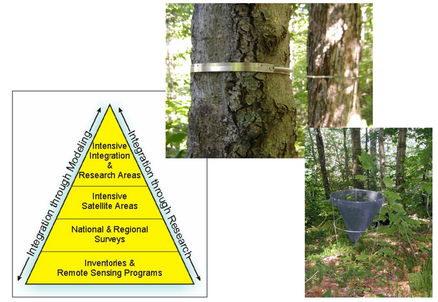
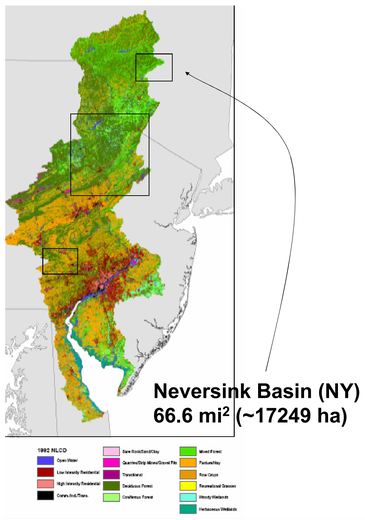


ABSTRACT

Methods are fairly well-developed for estimating terrestrial carbon (C) cycling rates at the plot scale for small-scale ecosystem science research. Techniques also exist to estimate terrestrial and aquatic C cycling rates at large scales, using stream monitoring data, inventory datasets, and/or modeling approaches. Still undeveloped, though, are techniques for linking the two types of monitoring datasets (terrestrial and aquatic) for complete C cycle estimation at both intensive and extensive study sites. These techniques are critical to a comprehensive understanding of net C exchange between terrestrial, aquatic, and atmospheric systems. We report results of a pilot test conducted as part of the interagency Collaborative Environmental Monitoring and Research Initiative (CEMRI) to link terrestrial and aquatic monitoring data for estimation of all components of the C cycle in a forested watershed in the Neversink Basin, in the Catskill Mountains of New York. Despite the homogeneity of soil conditions and forest types in the watershed, we found substantial differences in soil C stocks, aboveground biomass, annual wood biomass increment, annual litterfall, and modeled soil respiration among stands of similar forest type and similar age. We also found that downstream export of dissolved and suspended C in streamwater is directly related to the concentration of total suspended solids (TSS) in streamwater, but in this watershed it accounts for a very small proportion of the C fixed aboveground. The methods tested here will provide a template for similar efforts to integrate monitoring systems for complete C cycle estimation in regions where extensive monitoring systems exist.

STUDY REGION

Delaware River Basin, USA



Delaware River Basin characteristics:
- 12,700 square miles
- 7.2 million residents
- 7.0 million additional people rely on water diverted from the Basin

- 60% forested
- 24% agricultural
- 9% urban/residential

CEMRI

The Delaware Basin project was established in 2000 as part of the interagency Collaborative Environmental Monitoring and Research Initiative (CEMRI), which has the following purpose:

"To address ecosystem-level issues through testing of potential national-scale collaborative strategies among existing biological, terrestrial, aquatic, and atmospheric monitoring and research programs."

Literature cited

- Birdsey, R.A and G. M. Lewis. 2003. Carbon in U.S Forests and Wood Products, 1987-1997: State-by-state estimates. Newtown Square, PA: USDA Forest Service Northeastern Research Station General Technical Report NE-310.
- Curtis, P.S., P. Hanson, P. Bolstad, C. Barford, J.C. Randolph, H. P Schmid, K.B. Wilson. 2002. Biometric and eddy-covariance based estimates of annual carbon storage in five eastern North American deciduous forests. Agricultural and Forest Meteorology 113: 3-19.

Building on existing extensive monitoring systems maintained by USDA and USGS for combined terrestrial and aquatic C cycle estimation

OBJECTIVES of this project:

A. **Verify existing inventory-based estimates** of C stocks and fluxes

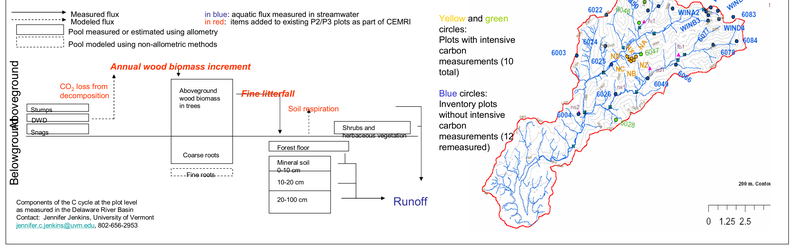
B. Develop and test **field methodologies** for more detailed estimation of C stocks and fluxes

C. Link estimates of **terrestrial and aquatic** C dynamics

METHODS

Study site (Neversink Basin, NY)

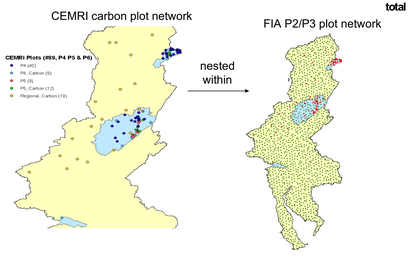
Field measurements



RESULTS

A. **Verify existing inventory-based estimates** of C stocks and fluxes

CEMRI carbon plot network



FIA P2/P3 plot network

C. Link estimates of **terrestrial and aquatic** C dynamics

terrestrial C fixation (Mg C/ yr):

litterfall (8 carbon plots)	24839
wood production (15 p4 plots)	24667
fine root production	24839
total	74345

atmospheric C loss (Mg C/ yr):

soil heterotrophic respiration	52007
decomposition of CWD	
total	52007

broad categories	watershed total (Mg)	% of total
live biomass	1932785	58.6%
snags	196574	6.0%
downed woody material	94886	2.9%
stumps	23779	0.7%
shrubs & herbs	7235	0.2%
forest floor	317159	9.6%
mineral soils (0-20 cm)	728066	22.1%
total	**3300484**	

aquatic C export (Mg C/ yr):

DOC	653
sediment	868
total	1521

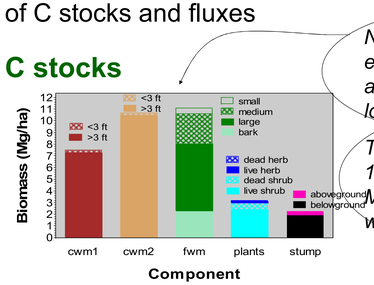
watershed C balance

inputs (Mg C per yr)	74345
outputs (Mg C per yr)	53525
watershed C accumulation (Mg C per yr)	20820
area-corrected C balance (Mg C per ha per yr)	1.21

RESULTS

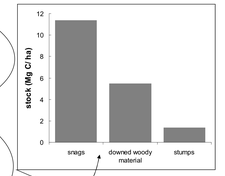
B. Develop and test **field methodologies** for more detailed estimation of C stocks and fluxes

C stocks

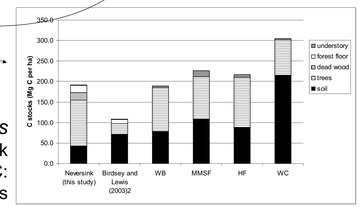


New methods for DWD estimation: bark, stumps and coarse material < 3 ft long.

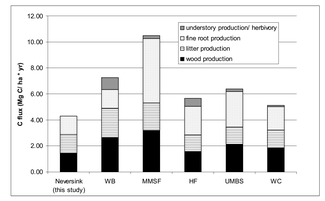
Total dead wood biomass 18.3 Mg C/ha (stumps 1.4 Mg C/ ha, or 7.5% of dead wood)



This study compared with literature values
Birdsey and Lewis (2003): all forests in New York
WB, MMSF, HF, and WC:
Curtis et al. (2002) estimates for Ameriflux sites



C fluxes



	Neversink (this study)	Curtis et al. (2002) WB	MMSF	HF	UMBS	WC
C fixation:						
wood production	1.43	2.64	3.20	1.55	2.11	1.86
litter production	1.44	2.26	2.13	1.30	1.33	1.35
fine root production	1.43	1.44	4.92	2.20	2.75	1.80
understory production/ herbivory		0.93	0.24	0.60	0.20	0.10
NPP (sum of fixation terms)	4.30	7.27	10.49	5.65	6.39	5.11
C losses:						
dead wood decay			0.92			
total soil respiration	6.03	9.50	12.07	8.00	11.32	8.10
heterotrophic soil respiration	3.02	4.75	6.04	4.00	5.66	4.05
NEP (=NPP-heterotrophic respiration)	1.29	2.52	3.54	1.65	0.73	1.06

CONCLUSIONS

- Aquatic C export is comparatively low in this watershed
  - Need to look at more watersheds with different cover types for comparison
- Soil respiration flux and fine root production are important contributors to C balance
  - Should characterize these parameters at large scales, not just for selected study sites or watersheds
- Sequential dbh measurements just as good/ easier to implement than dendrometer bands (>= 3 years between measurements)
- FIA is underestimating down dead wood biomass
- Plot variability suggests a) need for many field plots as verification and b) need to understand the degree to which select study sites (e.g. Ameriflux) are representative of large regions