TWENTY YEARS INTO A 150-YEAR SOIL MONITORING STUDY, SIGNIFICANT RESULTS!

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Introduction

- Ongoing monitoring of soils is essential for detecting, predicting and addressing environmental change.
- We have established a long-term soil monitoring study on 'unmanaged' forested sites in Vermont.
- Five 50 x 50 m plots are located in protected areas, three on Mt. Mansfield and two in the Lye Brook Wilderness Area (Fig. 1, Table 1).
- We have been monitoring carbon, nitrogen, exchangeable cations, and mercury (Hg).

Methods

- Each plot contains 100 5 x 5 m subplots with sampling dates assigned randomly (10 subplots are sampled on each date). See plot plan below (Fig. 2).
- Small pits are dug in the center of each subplot and the soils described and sampled by horizon. Typical soil profiles are shown in Fig. 3.
- Large samples are also taken of the Oi/Oe, the Oa and/or A, the top 10 cm of the B, and 60-70 cm depth (usually a C). Separate samples for Hg were taken from a fresh pit face from the Oa or A horizon.

Results

- Plots have been sampled five times, every five years beginning in 2002. Data from the 2022 sampling are not yet available.
- Carbon concentration in the Oa/A horizon (Fig. 4a) has had a wide range among sites. Carbon in the upper B horizon (Fig. 4b) has been less variable among sites.
- Except for the Mansfield Ranch site, exchangeable Ca in the B horizon (Fig. 4c) has been low while exchangeable Al (Fig. 4d) has been high.
- **Significant increases ($p < 0.05$) were found in Oa/A carbon at both Lye Road and Mansfield Underhill. The latter site also had significant increases in upper B horizon carbon concentrations and both exchangeable Ca and Al (Fig. 5).**
- Average total mercury (THg) concentration in the Oa or A horizon at each site has ranged from 144-505 µg/kg (Fig. 6), with no temporal trends yet detected. An interesting pattern appeared in the 2017 results in that samples with carbon higher than 30% (300 g/kg) had decreasing concentrations of THg (Fig. 7).

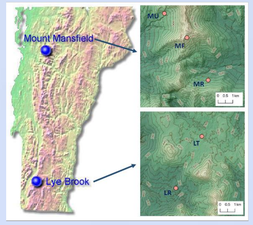

Figure 1. Location of monitoring plots.

Site	Abbrev.	Elevation (m)	Basal Area (m^2/ha)	Median dbh[a] for stems >5 cm	Stems/ha 2.5-5.0 cm (+)	Major Tree Species % of stems >5 cm dbh % of basal area
Lye Kelly Stand Road	LR	739	30.4	12.3	448	*Acer saccharum* 26%, 55%; *Fagus grandifolia* 65%, 32%; *Betula alleghaniensis* 3%, 7%
Lye Branch Pond Trail	LT	808	36.4	17	56	*Acer rubrum* 3%, 4%; *Acer rubrum* 28%, 55%; *Betula cordifolia* 38%, 22%; *Picea rubens* 26%, 8%
Mansfield Ranch Brook	MR	590	35.5	20.2	328	*Abies balsamea* 18%, 12%; *Acer saccharum* 63%, 77%; *Fagus grandifolia* 32%, 13%; *Fraxinus americana* 1%, 6%
Mansfield Forehead	MF	1140	33.6	8.1	2416	*Abies balsamea* 97%, 96%; *Betula cordifolia* 2%, 3%
Mansfield Underhill State Park	MU	695	36.1	13.5	236	*Betula alleghaniensis* 45%, 78%; *Fagus grandifolia* 13%, 7%; *Abies balsamea* 13%, 5%; *Picea rubens* 15%, 3%; *Betula cordifolia* 5%, 5%

[a] diameter at breast height (1.35 m)

Table 1. Site characteristics

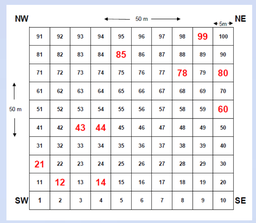

Figure 2. Example of a plot plan.

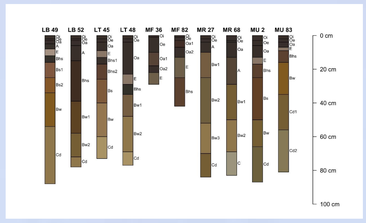

Figure 3. Typical soil profiles at each site

Carbon, exchangeable calcium and exchangeable aluminum results

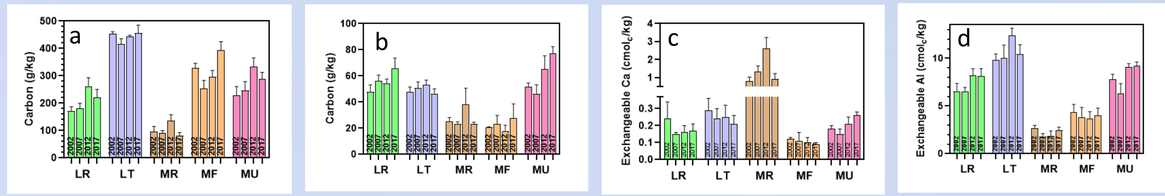

Figure 4. (a) Carbon concentration in the Oa/A horizon by site and year. (b) Carbon in the B horizon. (c) Exch. Ca in the B horz. (d) Exch. Al in the B horz.

Significant temporal trends in carbon and cations

2.4% annual increase in carbon in the Oa/A horizon ($p = 0.047$)

3.3% annual increase in exch. Ca in the B horizon ($p = 0.033$)

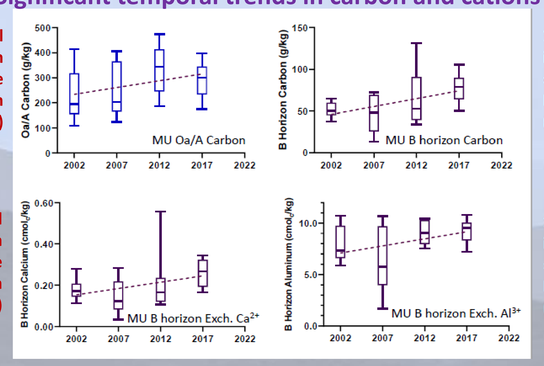

Figure 5. Significant temporal trends at the Mansfield Underhill sites.

3.7% annual increase in carbon in the B horizon ($p = 0.006$)

1.5% annual increase in exch. Al in the B horizon ($p = 0.017$)

Results have been published!

…in the Journal of Environmental Analysis and Assessment (2021) 193:776

Data and methods are also published and available on the FEMC website.


Environ Monit Assess (2021) 193:776
https://doi.org/10.1007/s10661-021-09550-9

Long-term monitoring of Vermont's forest soils: early trends and efforts to address innate variability

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Mercury results

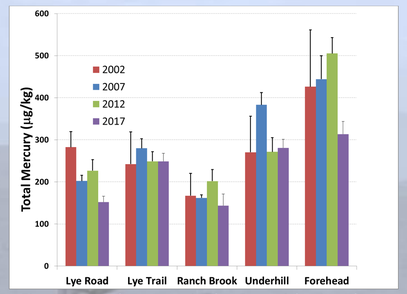


Figure 6. Total mercury in the Oa or A horizon by site and year

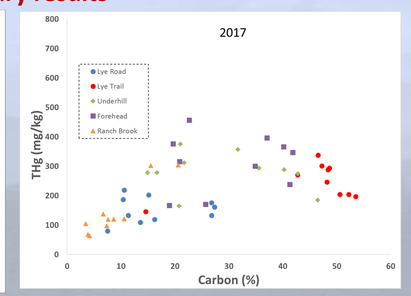
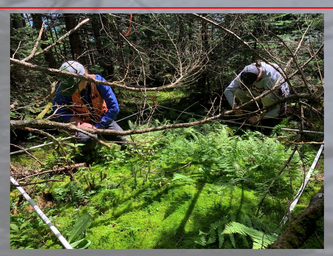


Figure 7. Total mercury trends from the 2017 sampling. Note the increase and then decrease in THg with increasing soil carbon.

Going Forward

Monitoring will continue on a five-year cycle to provide a time-series of data capable of detecting change. Samples are being archived to allow reanalysis over time. Current plans are to sample for 130 more years.

We need the next generation of soil scientists to join the project. Please contact us if interested. dross@uvm.edu



Vegetation monitoring

A suite of vegetation measurements are also performed every five years. There were nonsignificant trends for species composition at Mansfield Underhill, with decreasing *A. balsamea* and increasing *P. rubens;* and at Lye Trail, with decreasing *B. cordifolia.*

Above: Images from the 2022 sampling. Below: A suite of soil profiles from the five different sites.

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