

Long-Term Monitoring of Forest Soil Mercury by the Vermont Monitoring Cooperative

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Introduction

- Ongoing monitoring of total mercury (THg) concentration in soils is essential for detecting, predicting and addressing environmental change.
- We have established a long-term soil monitoring study on forested sites in the northeastern USA where annual wet deposition of Hg has been in the range of 10 mg/m².
- Five 50 x 50 m plots were located in protected areas, three on Mt. Mansfield and two in the Lye Brook Wilderness Area.
- In addition to Hg, we have been monitoring carbon, nitrogen, pH and exchangeable cations.

Methods

- Each plot contains 100 5 x 5 m subplots with sampling dates assigned randomly (10 subplots sampled on each date). See plot plan below.
- Small pits were dug in the center of each subplot and the soils were described and sampled by horizon.
- Separate samples for THg were taken from a fresh pit face as pictured below. The uppermost sampleable humified soil horizon was taken, either an Oa (H) or A horizon.

Results

- Plots were sampled in 2002, 2007 and 2012 (analysis still in progress for the latter).
- Mean Oa or A horizon THg concentration at each site ranged from 162 to 444 µg/kg (Fig. 1) with no consistent trend between years.
- There was a trend towards greater THg concentration at higher elevation, consistent with greater deposition (Fig. 2)
- Carbon concentration in the Oa/A horizon also had a wide range among sites (Fig. 3) and there was an increasing trend in THg with greater C concentration.



Jamie Shanley and Stu Clark of the USGS sampling for THg

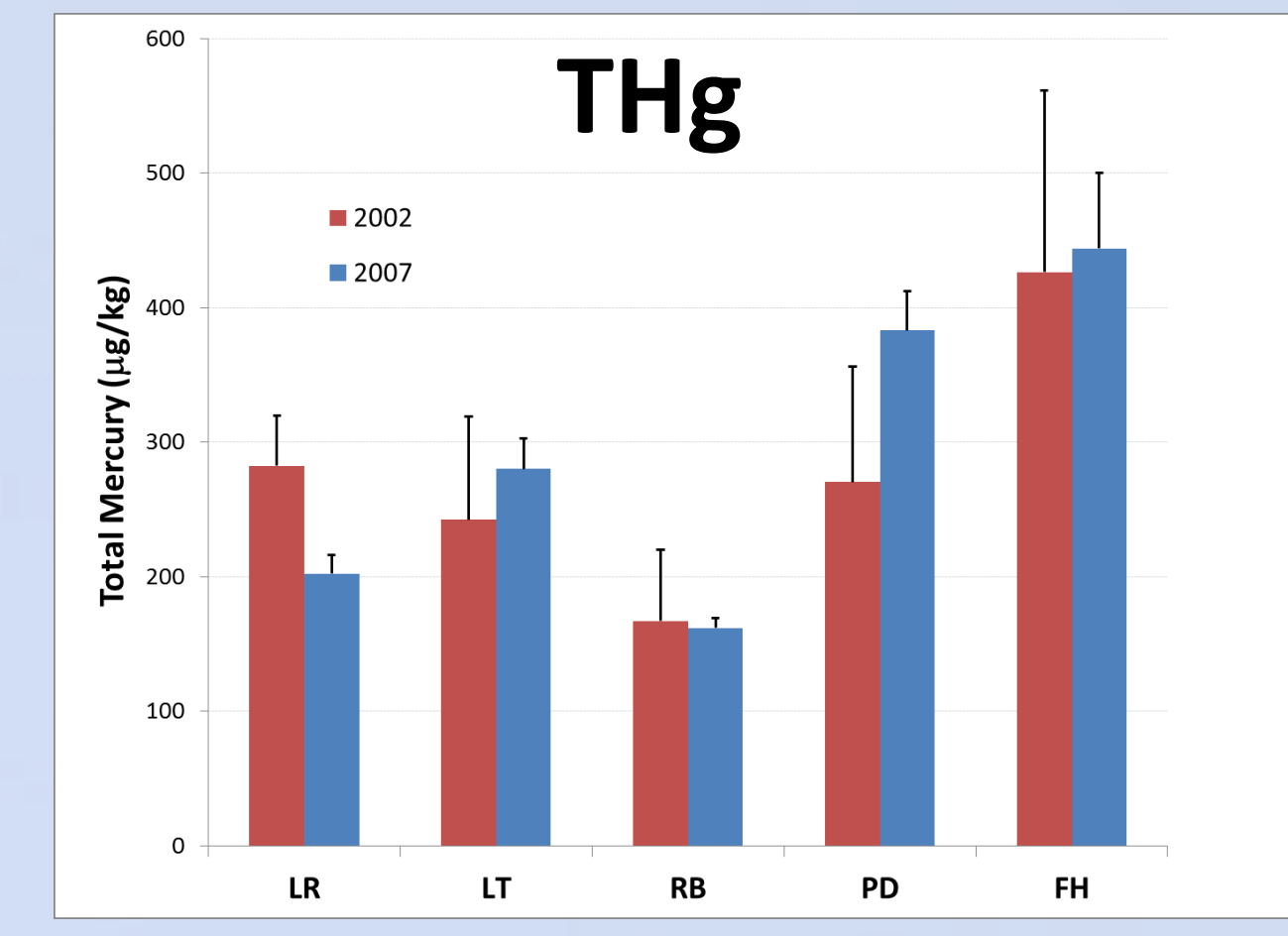
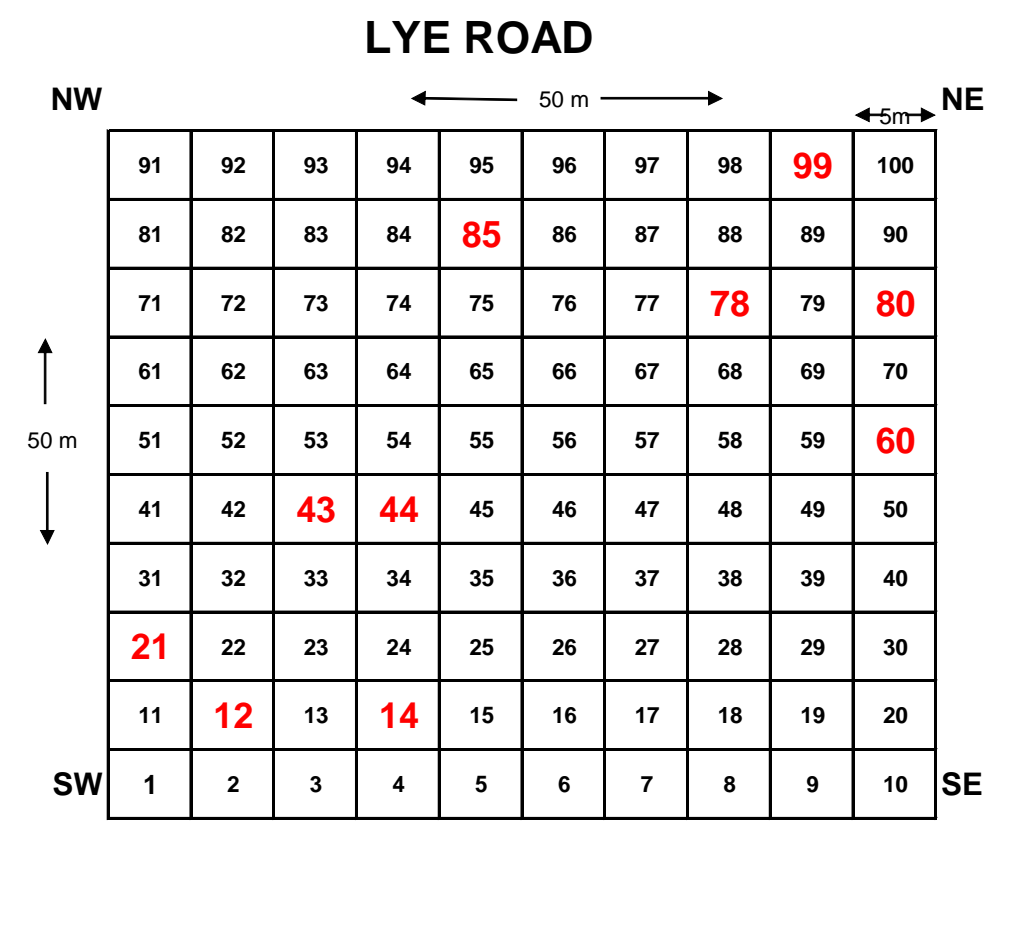


Figure 1. Mean total Hg conc. in the Oa/A horizon by plot and year. See Table 1 for site abbreviations. Error bars are SE.

Abbrev.	Name	Elevation (m)	Soil Classification (US system)	Dominant Trees
LR	Lye Road (Kelley Stand)	739	coarse-loamy, mixed, frigid, Aquic Haploorthods	<i>Fagus grandifolia</i> , <i>Acer saccharum</i> , <i>Betula alleghaniensis</i>
LT	Lye Trail (Branch Pond)	808	coarse-loamy, mixed, frigid, Aquic Haploorthods	<i>Acer rubrum</i> , <i>Betula papyrifera</i>
RB	Ranch Brook (Mansfield)	590	coarse-loamy, mixed, frigid, Aquic Dystrudepts	<i>Acer saccharum</i> , <i>Fagus grandifolia</i>
PD	Polka Dot (Mansfield)	895	coarse-loamy, mixed, frigid, Aquic Haploorthods	<i>Betula alleghaniensis</i> , <i>Abies balsamea</i>
FH	The Forehead (Mansfield)	1140	coarse-loamy Lithic Cryorthent	<i>Abies balsamea</i> , <i>Picea rubens</i>

Table 1. Site characteristics



Typical plot plan (subplots in red were sampled in 2002)



Podzol soil horizon sequence from the Lye Road site. THg was measured in the Oa horizon.

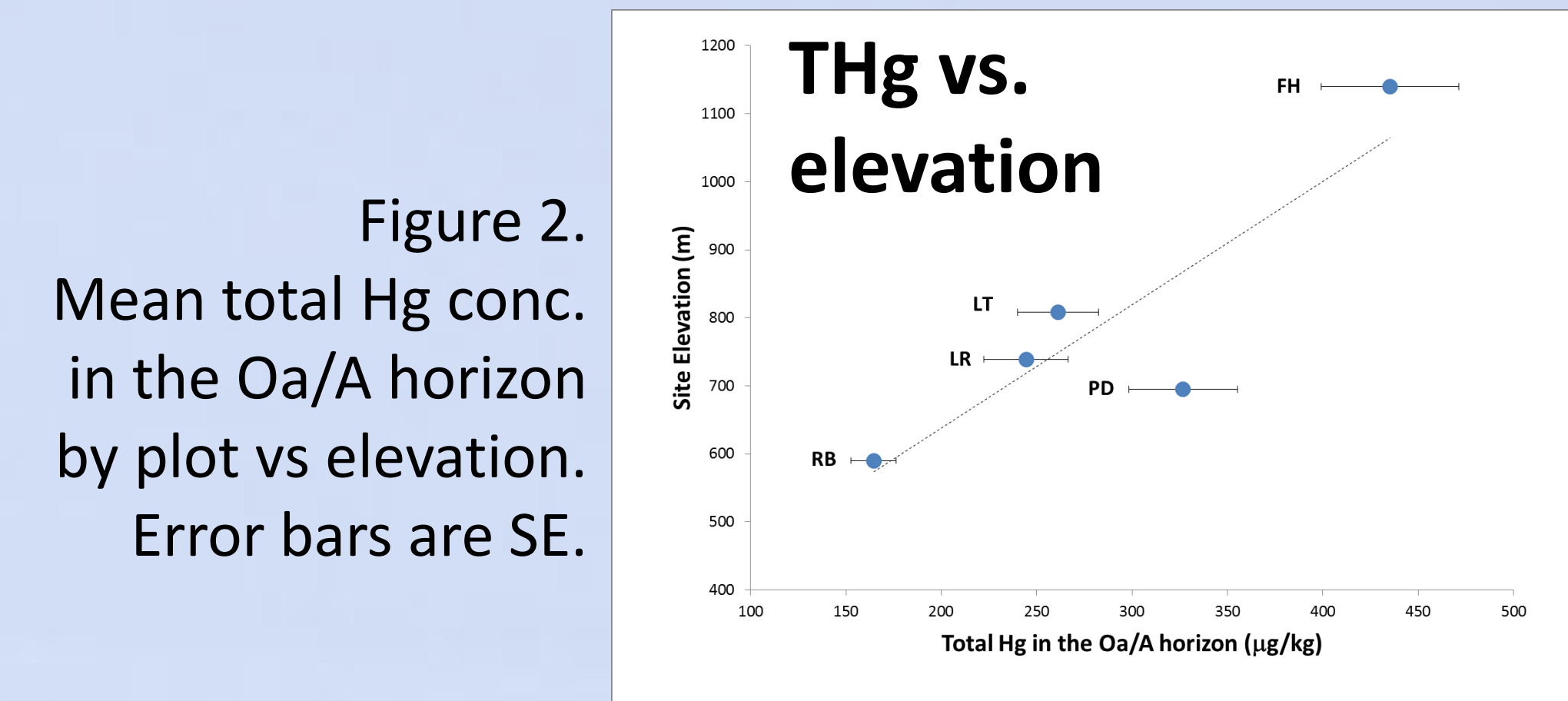


Figure 2. Mean total Hg conc. in the Oa/A horizon by plot vs elevation. Error bars are SE.

Discussion

- The differences among sites are likely due to an interaction between elevation (increased THg deposition) and soil carbon concentration (increased THg retention).
- Recent work at 15 lower elevation sites (mean 424 m) in Vermont found 283 and 131 µg/kg THg in Oa and A horizons respectively (Juillerat *et al.* 2012 DOI: 10.1002/etc.1896). THg pools in the forest floor were strongly related to carbon pools.
- Monitoring will continue on a regular basis to provide a time-series of data capable of detecting change.

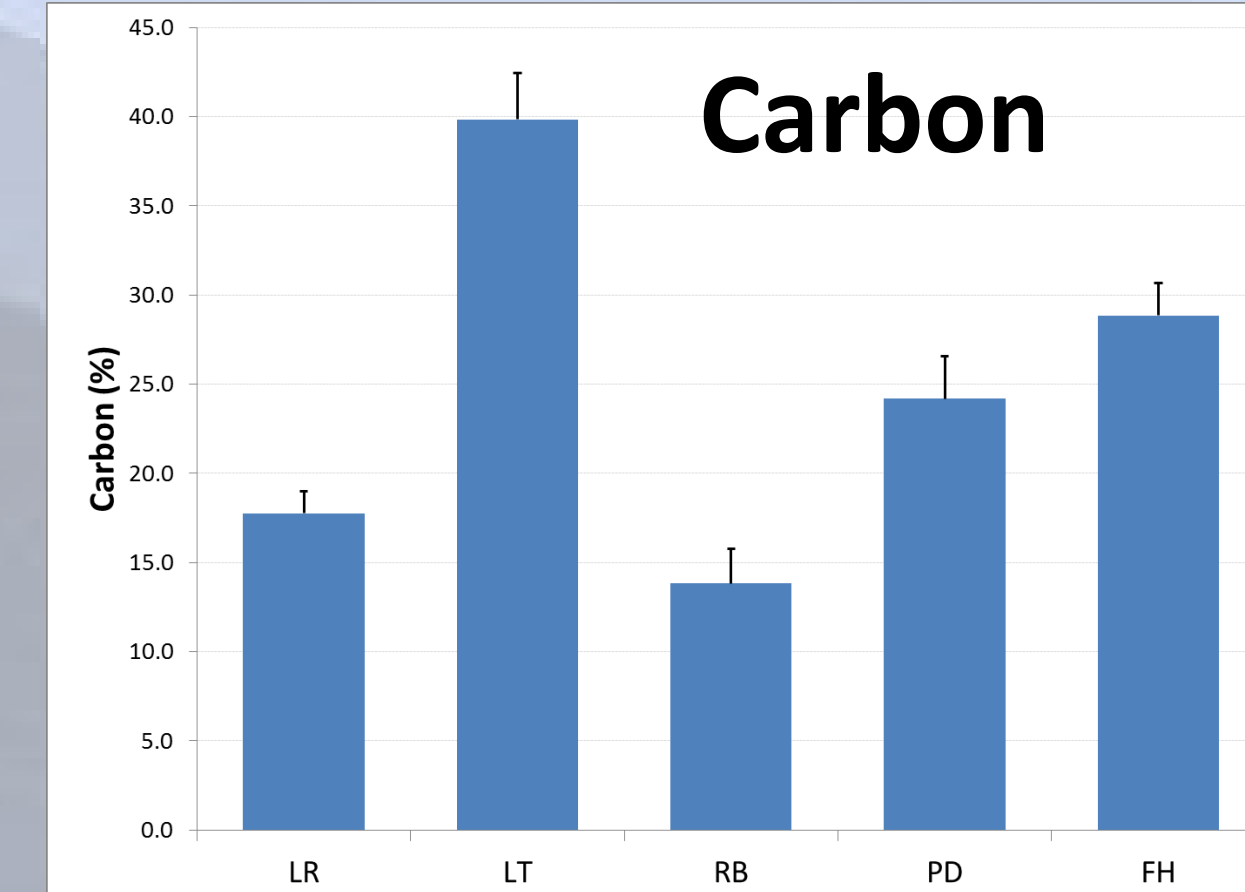


Figure 3. Mean carbon at each plot.

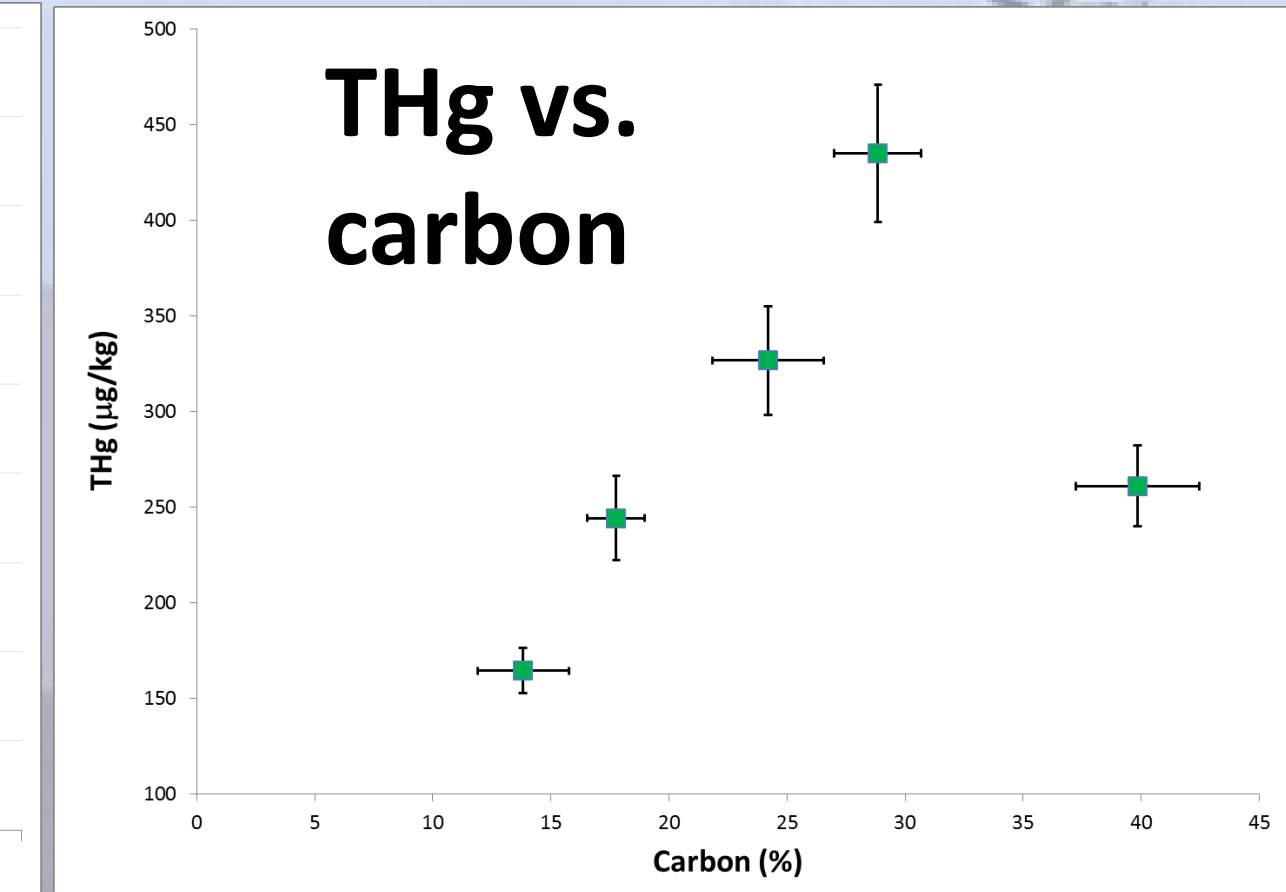
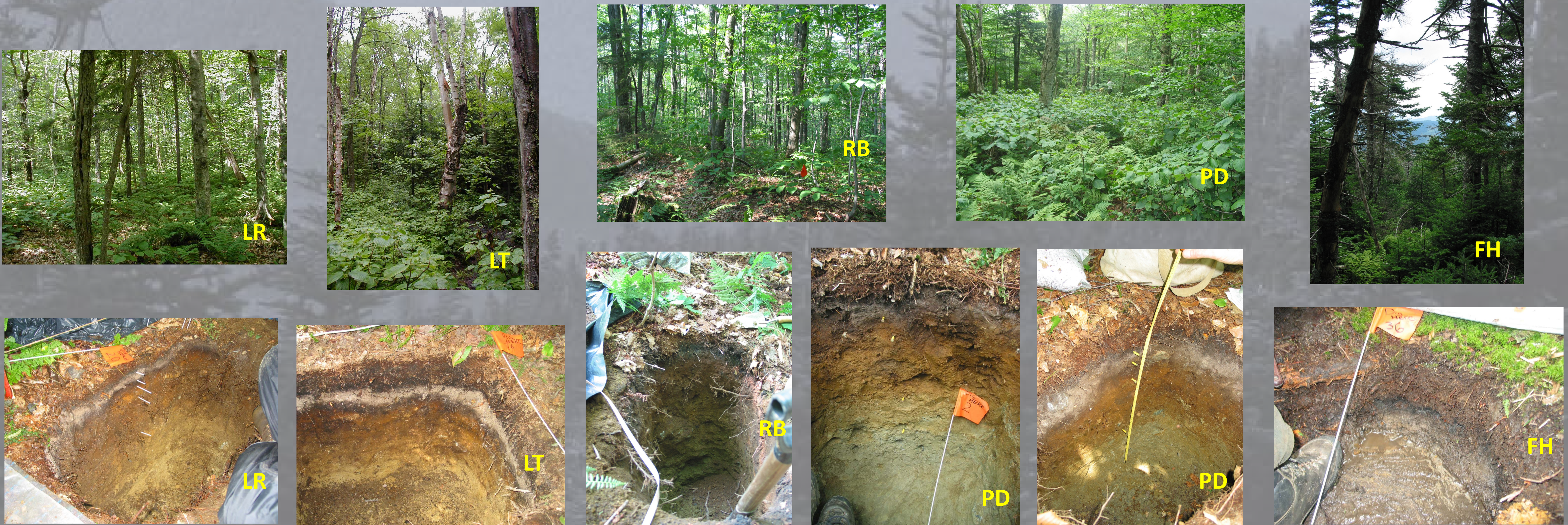


Figure 4. THg vs C at each plot.



Each area has a **Soil Climate Analysis Network (SCAN)** site (located at LT and PD). The SCAN objectives are to collect long-term data on weather, soil moisture and soil temperature to complement measurements of physical, chemical, and biological parameters at the long-term soil monitoring sites that have been established nearby. For more information, see: <http://www.wcc.nrcs.usda.gov/scan/>

Views of the forest and representative soil profiles at each plot. The two profiles from PD show different degrees of podzol expression. The FH soils were at high elevation (for Vermont) and usually shallow to bedrock. Samples for THg were taken from the dark near-surface horizon (just above the grey E horizon).



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The **Vermont Monitoring Cooperative (VMC)** was established in 1990 to track changes occurring in Vermont's forests. Only limited information about the health and baseline conditions of forested ecosystems was available at that time. Vermont lacked the ability to perceive subtle changes in ecosystem condition over time and thus to be able to identify forces affecting forest ecosystem health and productivity. VMC was envisioned and created to collect, assemble, and distribute high-quality, documented data and information to better understand environmental changes and their impacts on forested ecosystems.