# Sixteen-Year Update on Vermont Long-term Soil Monitoring Study

Don Ross, University of Vermont
Thom Villars, USDA NRCS
Scott Bailey, USFS Northern Research Station
Angie Quintana, USFS GMNF
Jim Duncan, VT Forest Ecosystem Monitoring Cooperative

# Initial Project Goals:

1. Establish five 50 x 50 m relatively uniform plots in sites associated with the Vermont Monitoring Coop.
2. Sample plots at designated intervals: 0, 5, 10, 25, 50, 100, 150, and 200 years (with 2 other times in reserve)

   **Year 0 = 2002**
3. Analyze initial samples to determine baseline values.
4. Archive samples for later comparisons.
5. Protect the plots for future monitoring.

# 5 Monitoring Sites:

- Mt. Mansfield Ranch Brook
  - northern hardwood
- Mt. Mansfield Forehead
  - high elevation spruce/fir
- Mt. Mansfield Underhill State Park
  - transitional forest
  - SCAN site
- Lye Brook “Road”
  - northern hardwood
  - SCAN site
- Lye Brook “Trail”
  - transitional forest

Underhill State Park
Forehead
Ranch
Brook
7189 ft

Stratton
Route 7
Lye Trail
Lye Road
© 2018 Google

## Sampling years have been:
2002, 2007, 2012, 2017…

## Sampling Protocols for 2007, 2012, 2017:

**Four large sample bags collected from each soil pit:**

1. Oi and Oe combined: Litter layer
2. Oa and/or A: near-surface humified horizons
3. B horizon: Top 10 cm
4. Between 60-70 cm (usually is the C horizon)

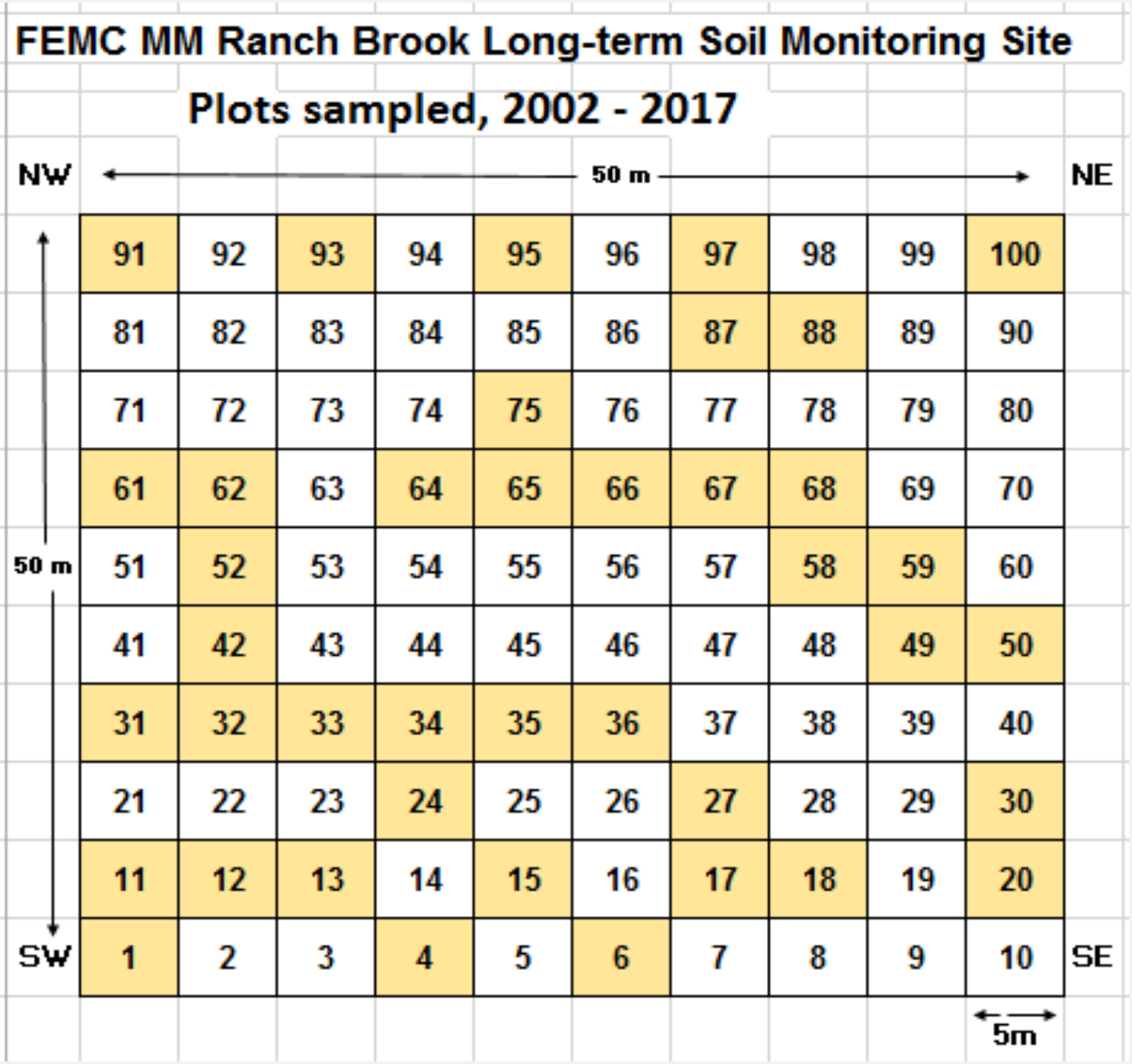
**Also collected small samples of each genetic horizon.**

# Four bulk samples taken from each soil pit

# Genetic horizons at each soil pit sampled in smaller bags

## FEMC MM Ranch Brook Long-term Soil Monitoring Site

### Plots sampled, 2002 - 2017




| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 91 | 92 | 93 | 94 | 95 | 96 | 97 | 98 | 99 | 100 |
| 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 |
| 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 |
| 61 | 62 | 63 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
| 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 |
| 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

Typical site plan with 100 5x5m plots.

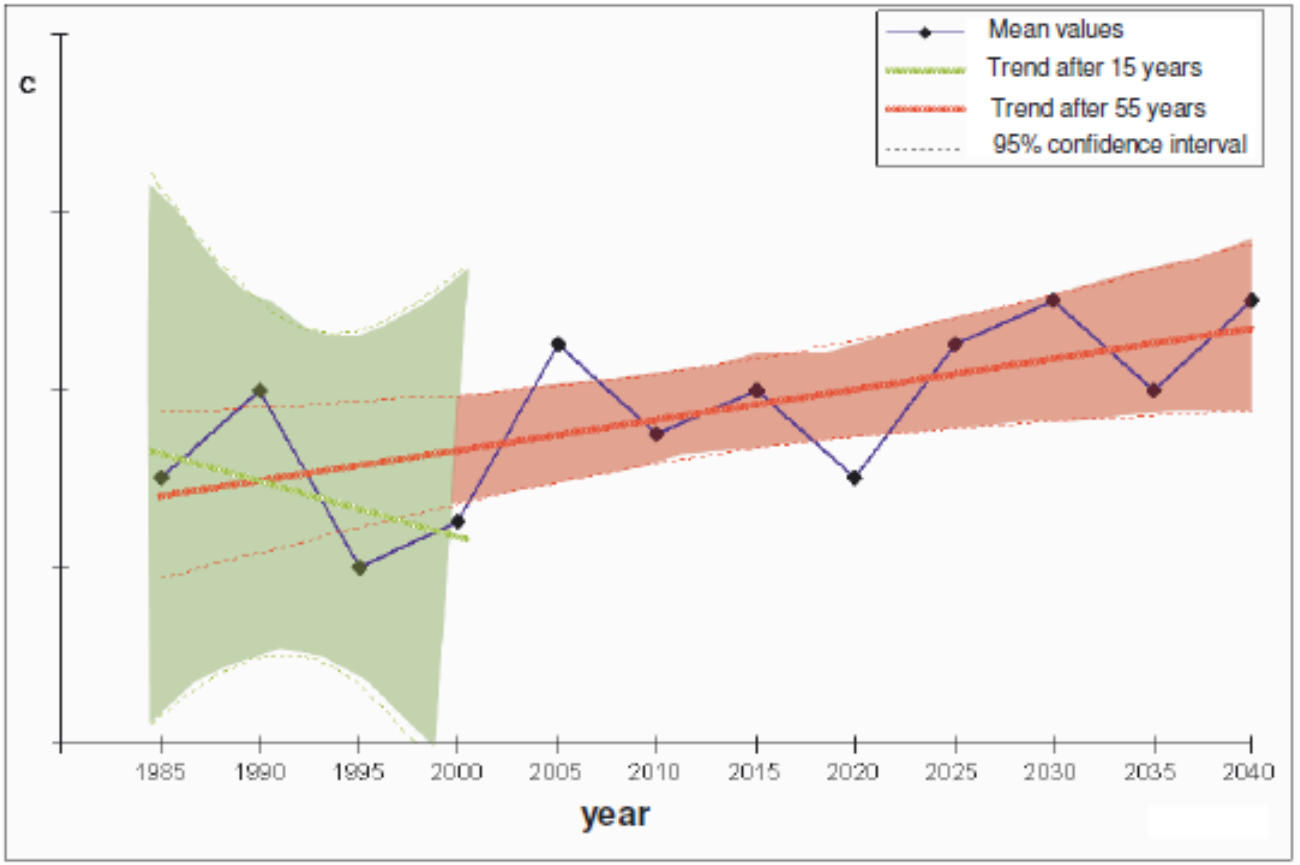
Plots in yellow have been sampled in 2002-2017 (40 plots to date).

# Overview and experiences of the Swiss soil monitoring network over 25 years
# - Focus on forest soils -

André Desaules
andre.desaules@art.admin.ch

**Lesson 2:** Trends can be identified and certified only after sufficiently intense and long measurement series. Measurements within the noise cannot be interpreted. With increasing number of measurements and accurracy noise can be reduced and trends earlier detected. This is the foundation of pleading for increasing measurement periodicity in soil monitoring as well.

# 2) Increasing measuring periodicity



# Extending the 5-year intervals

- Starting in 2017, each of remaining 5x5m sampling plots was subdivided into four quadrants (2.5x 2.5m).
- Plots are now located and marked by surveyors.
- This provides a possible 280 remaining subplots or 28 sampling times or 140 more years at 5-year intervals (beginning 2017).
- The 200-year study is likely now a 150-year study.

Over **1800 soil samples** have been collected since 2002 at the 5 study sites.

The last three sampling rounds have each generated over 500 unique soil samples. These are used for lab analysis and are archived at UVM.

**Samples taken by genetic horizon**

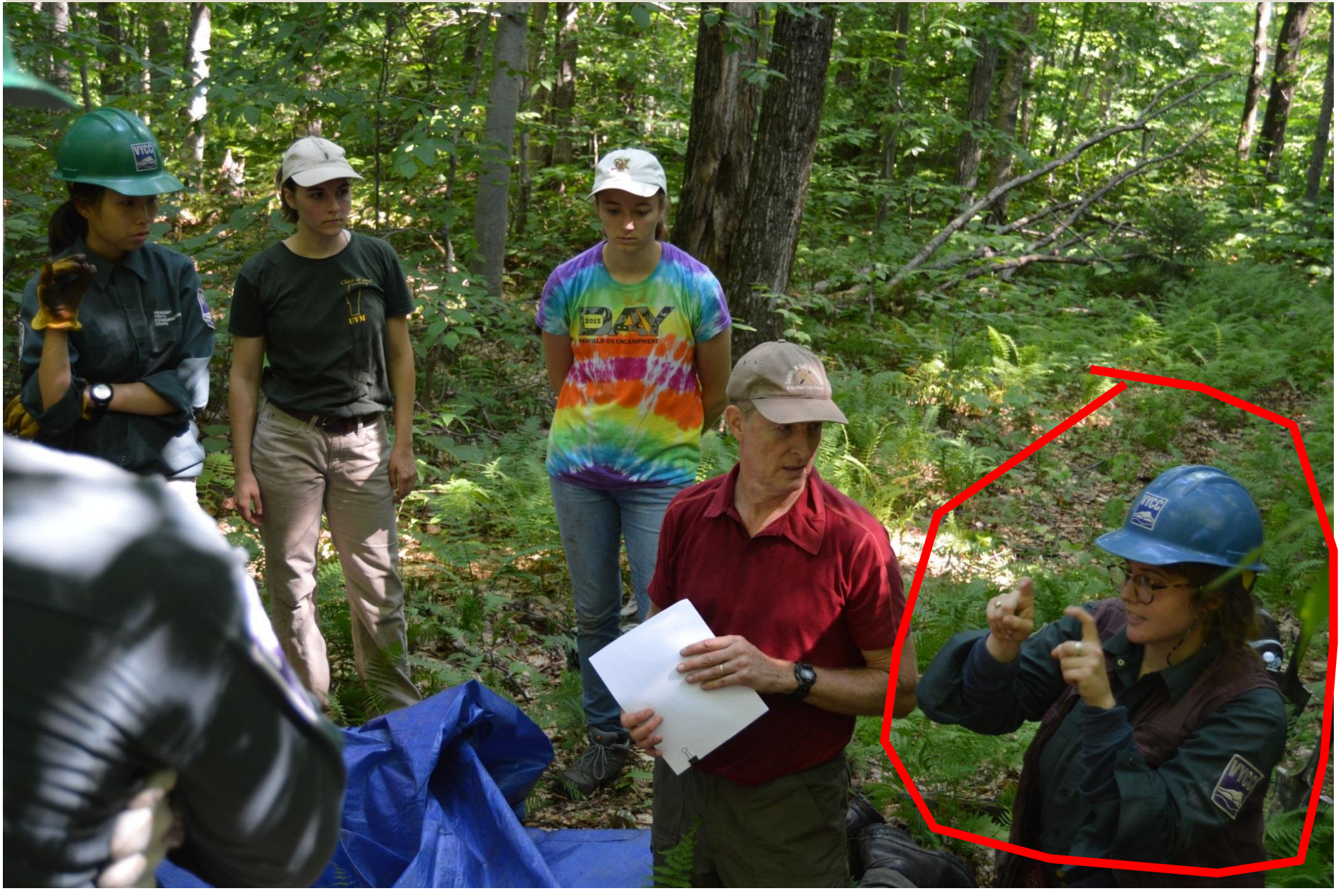
| Horizon | 2002 | 2007 | 2012 | 2017 |
|---|---|---|---|---|
| Oi | - | 39 | 50 | 48 |
| Oi/Oe | - | 9 | - | - |
| Oe | - | 36 | 48 | 50 |
| Oa | 49 | 48 | 48 | 44 |
| A | 22 | 21 | 25 | 30 |
| E | 30 | 30 | 32 | 27 |
| B | 91 | 129 | 126 | 118 |
| BC | 12 | - | - | - |
| C | - | 28 | 42 | 40 |
| **Total** | **204** | **340** | **371** | **357** |

**Large samples taken by horizon or depth increment**

| Sample zone | 2007 | 2012 | 2017 | |
|---|---|---|---|---|
| Oi/Oe | 50 | 50 | 50 | |
| Oa and/or A | 50 | 50 | 50 | |
| A | - | 2 | - | |
| E | 8 | 9 | 4 | |
| top 10 cm of B | 44 | 46 | 46 | |
| 60-70 cm | 40 | 40 | 44 | |
| **Total** | **192** | **197** | **194** | **=1855** |

# VYCC crew getting digging instructions on 2017 Day One at Ranch Brook site

# Kat, VYCC, using sign (ASL) with her co-workers



# Scott Bailey, USFS, and Emily Piersiak, UVM, sampling at Forehead site

# Angie Quintana– attacking a soil pit

Customer Owned an
1936 - 1996

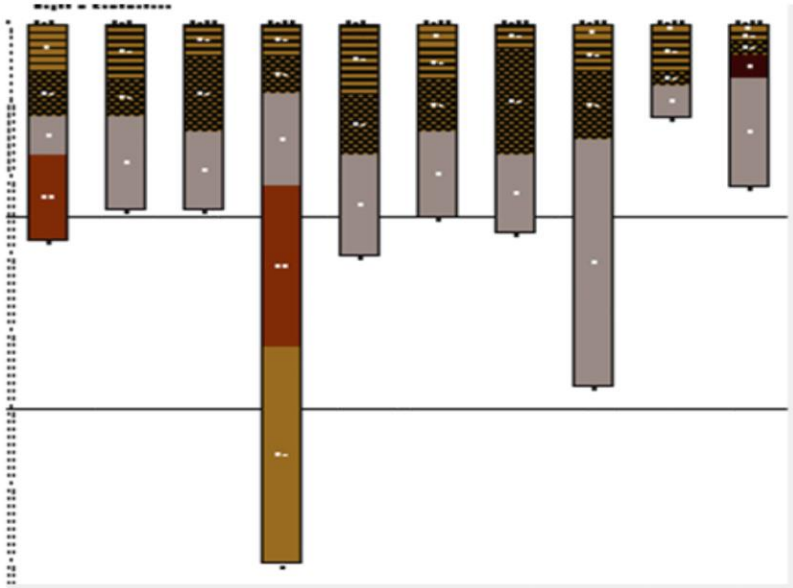
Class of 2012
UVM

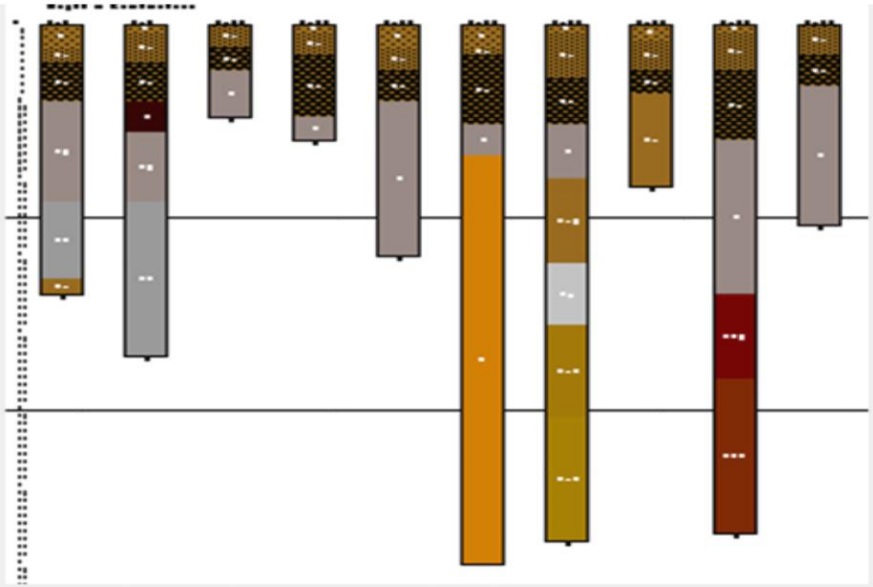
Ranch Brook
2002

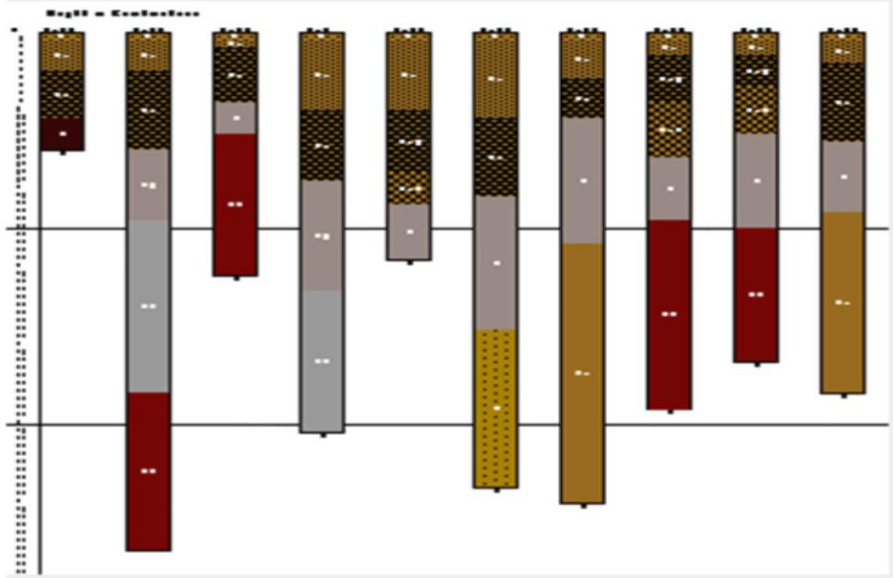
Underhill State Park or ‘Polka-Dot’, 2400’

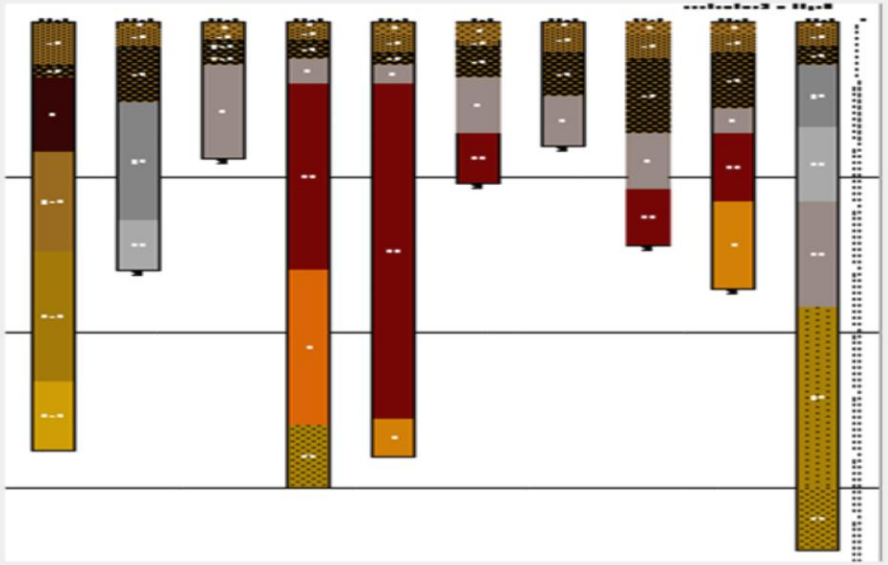
Forehead,
3600’

# Forehead soil profiles – all years
# FH is only site that has bedrock within depth of study







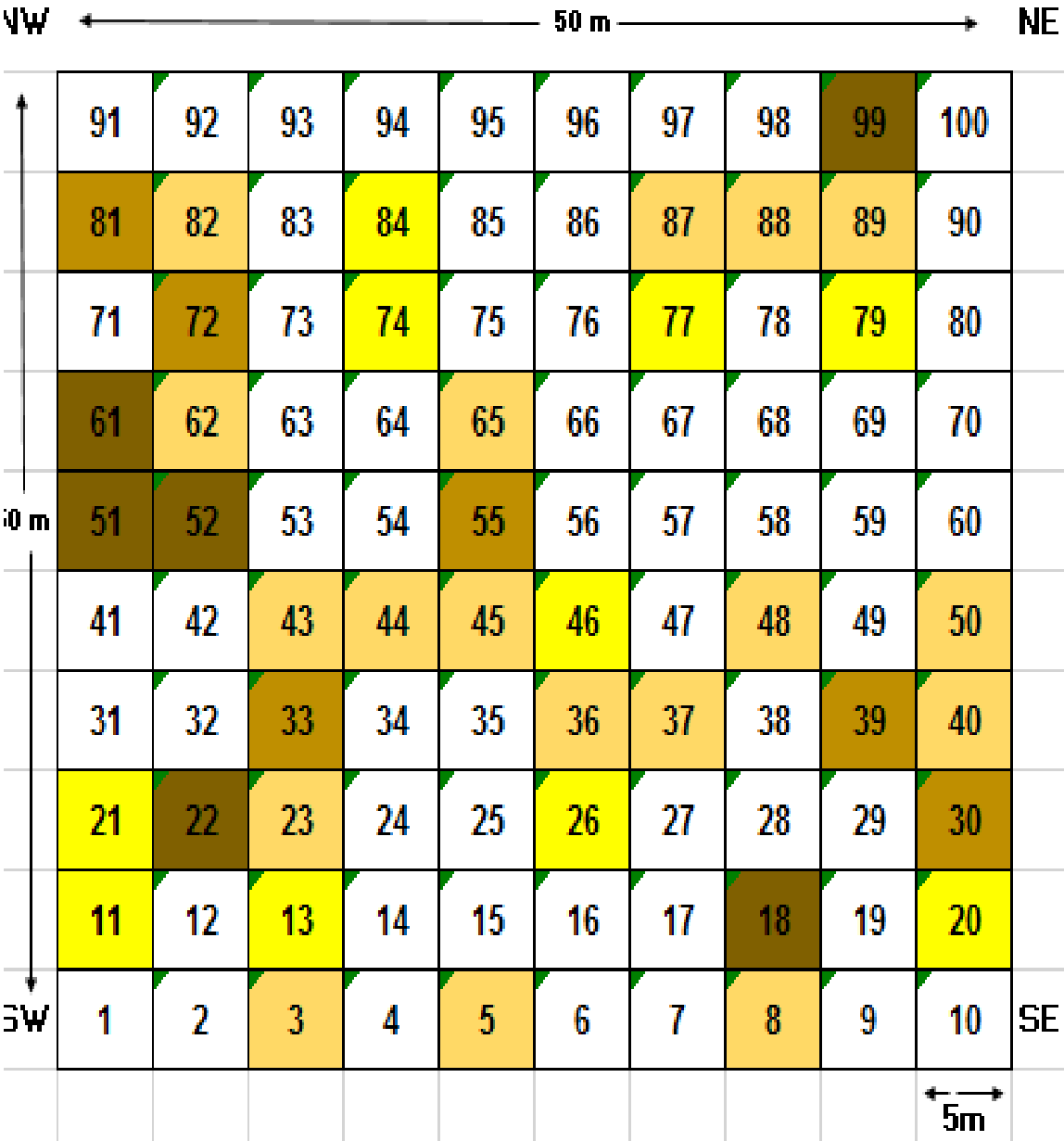


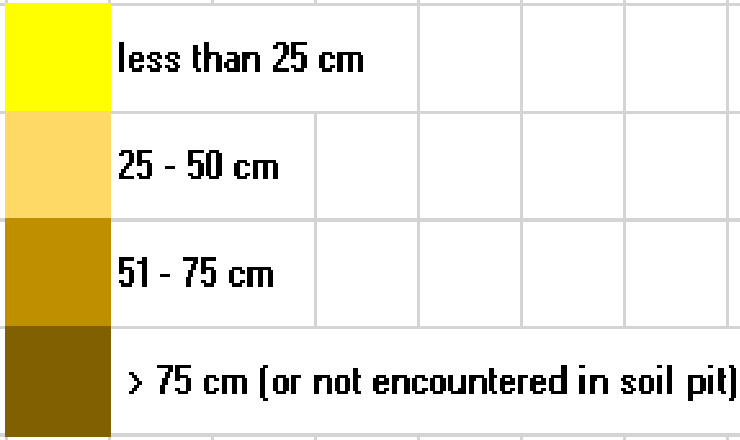
NE
87

Forehead

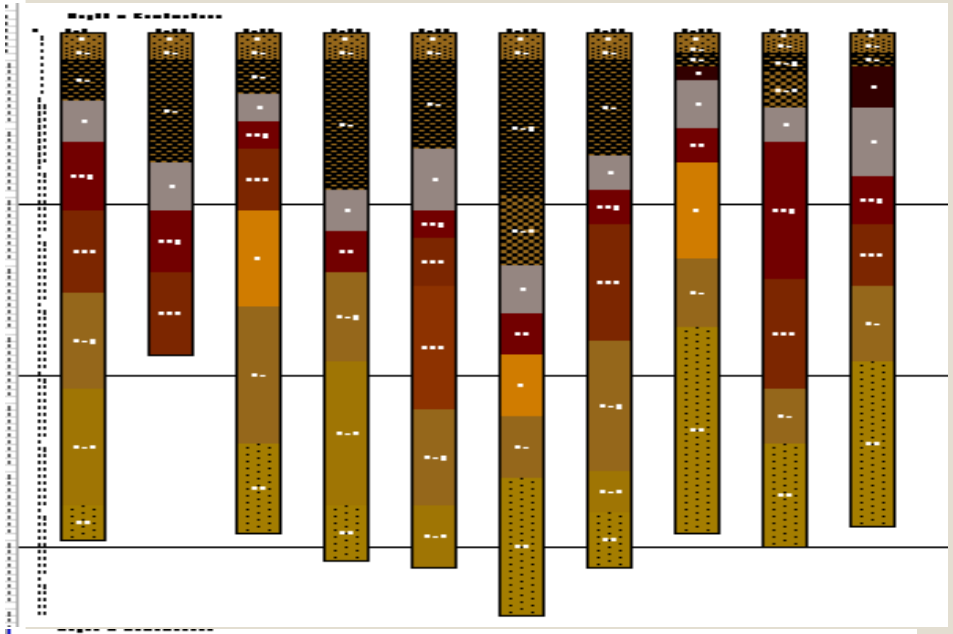
# FEMC Long-term Soil Monitoring Project

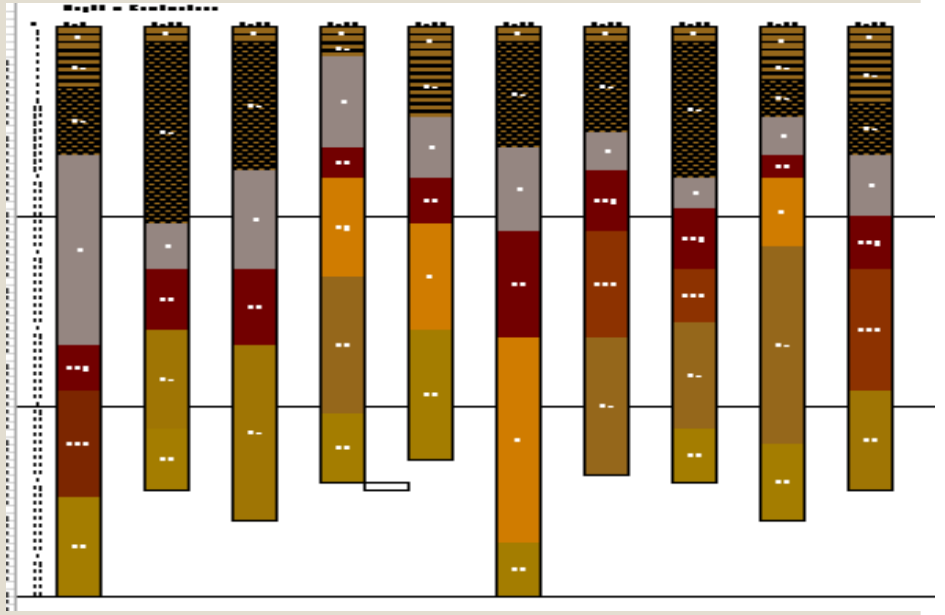
## MM Forehead - Depth to Bedrock from Surface

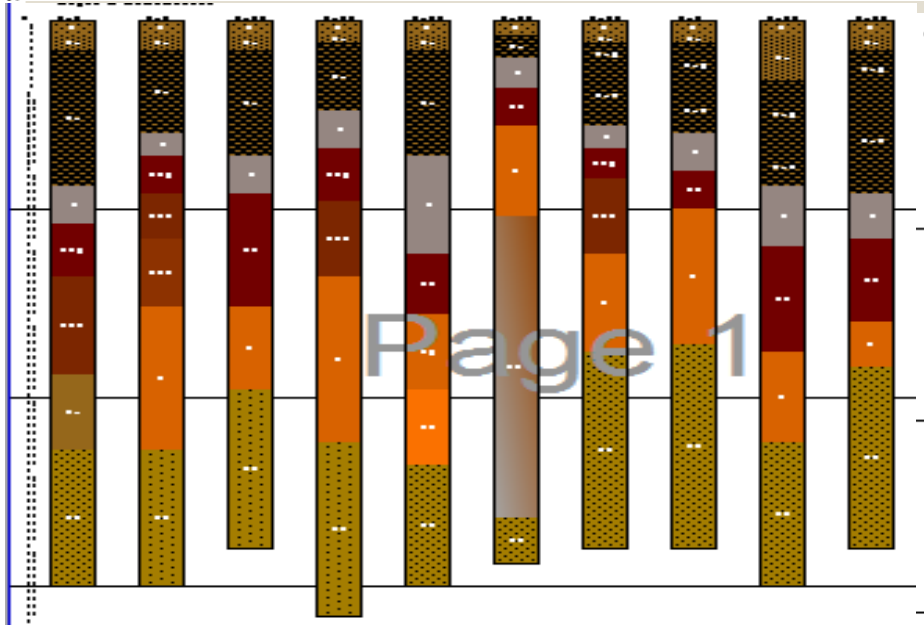


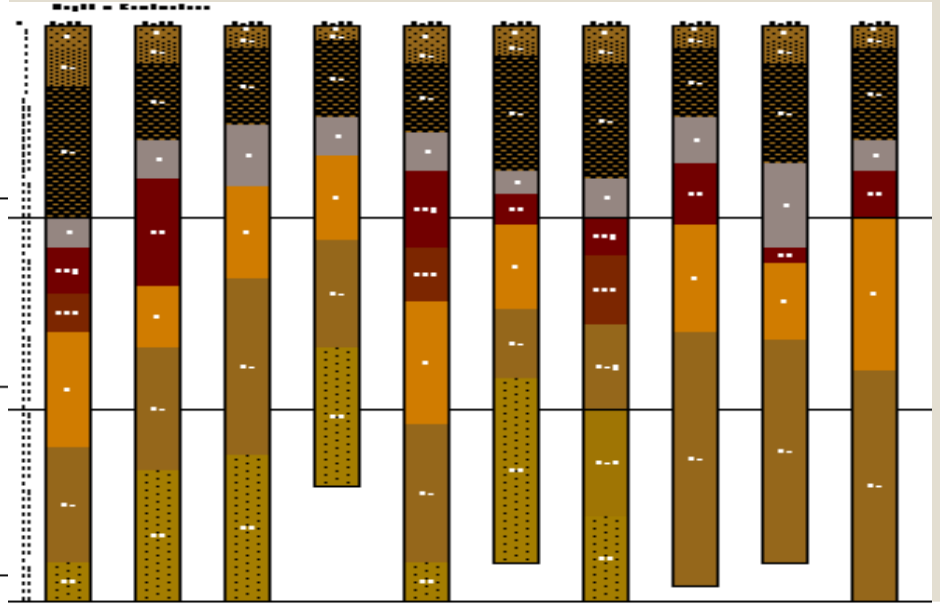
# Lye Brook Trail soil profiles – all years







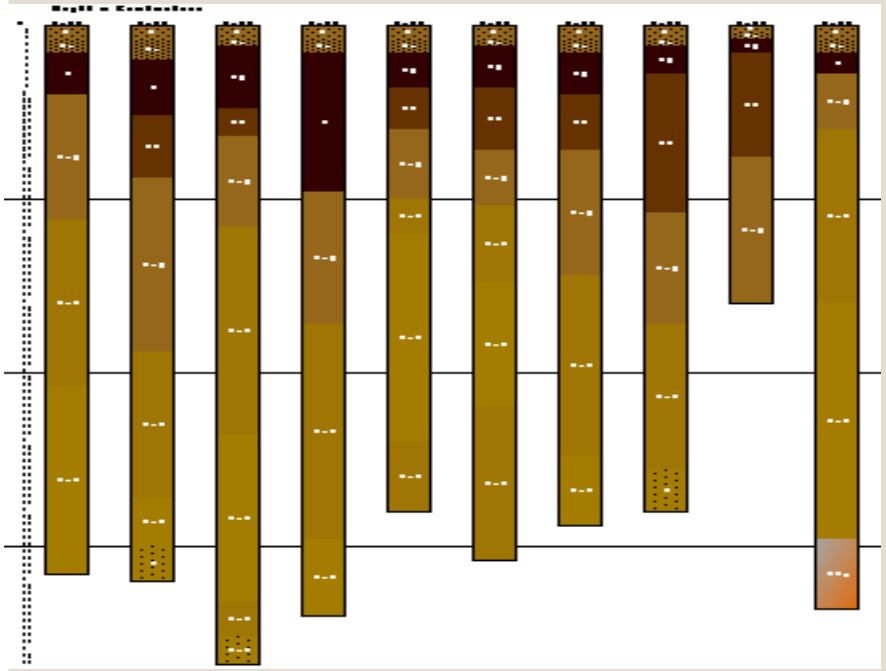
Page 1

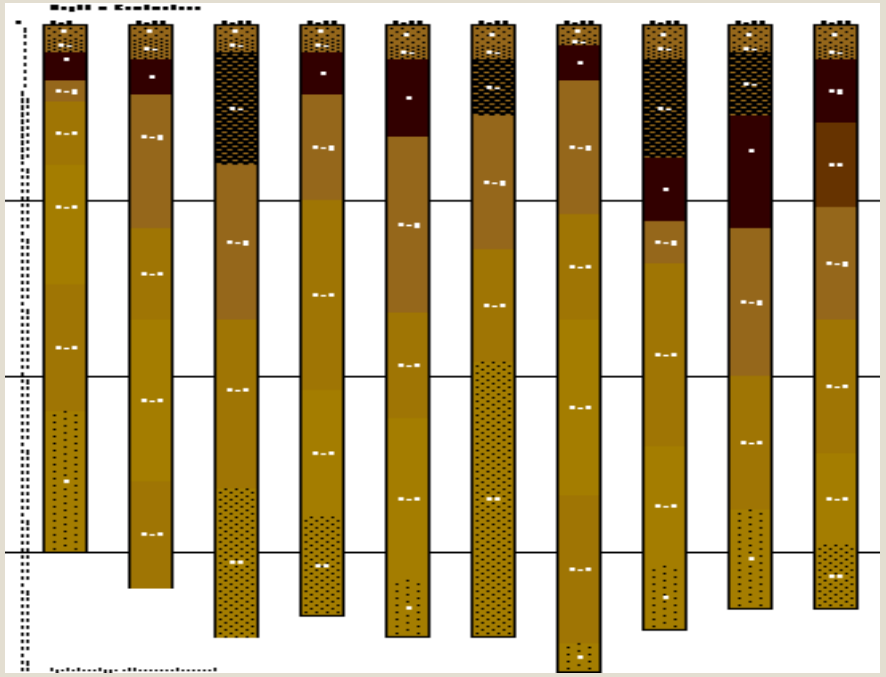


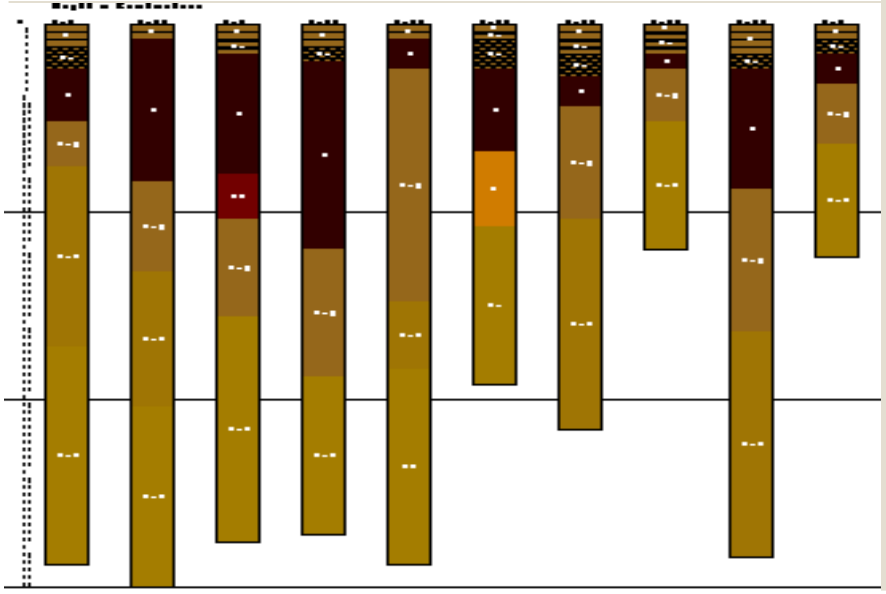
# Lye Brook Trail plot 1 with thick O horizon

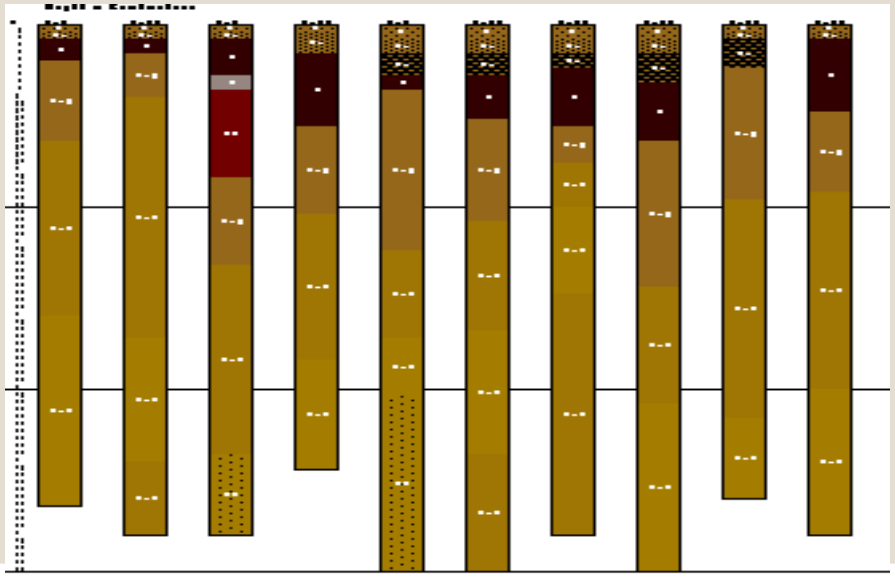
# Lye Brook Trail plot 6

# Ranch Brook soil profiles – all years







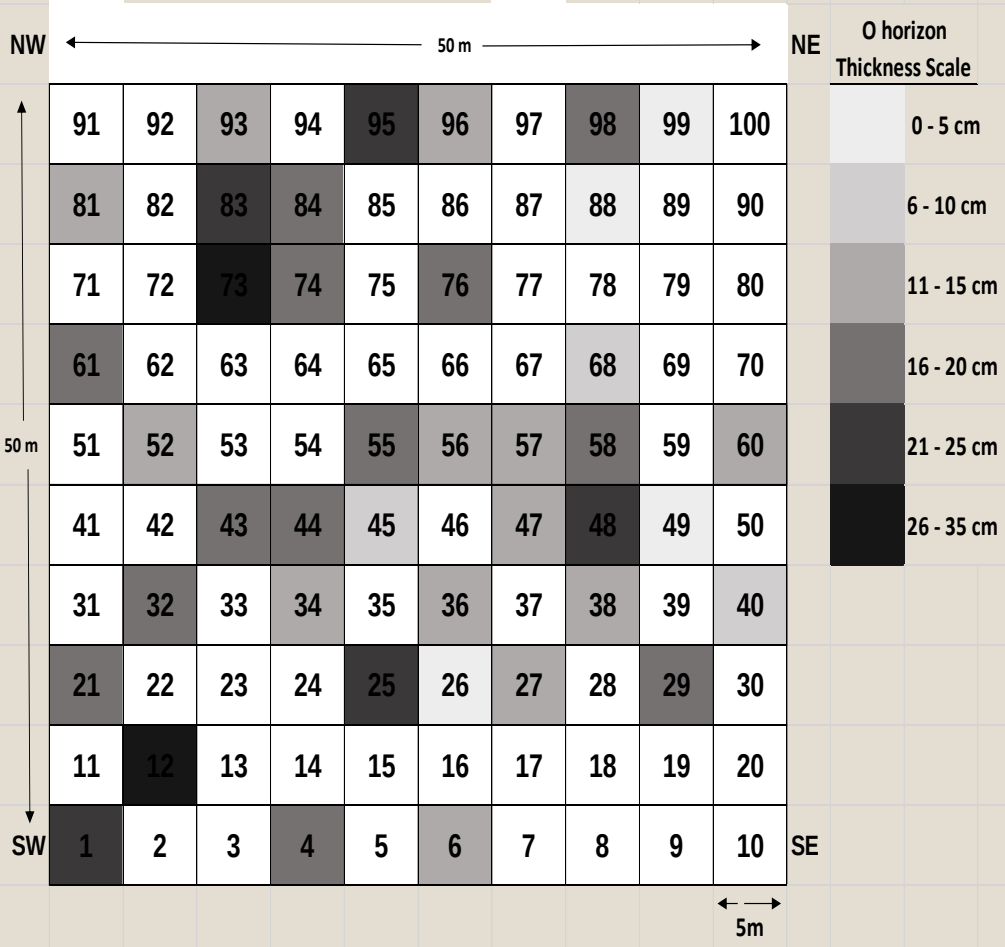


# Ranch Brook plot 15 with shallow O horizon

# Range in thickness of organic soil layers - Lye Brook Trail vs Ranch Brook

FEMC Long-term Soil Monitoring Project

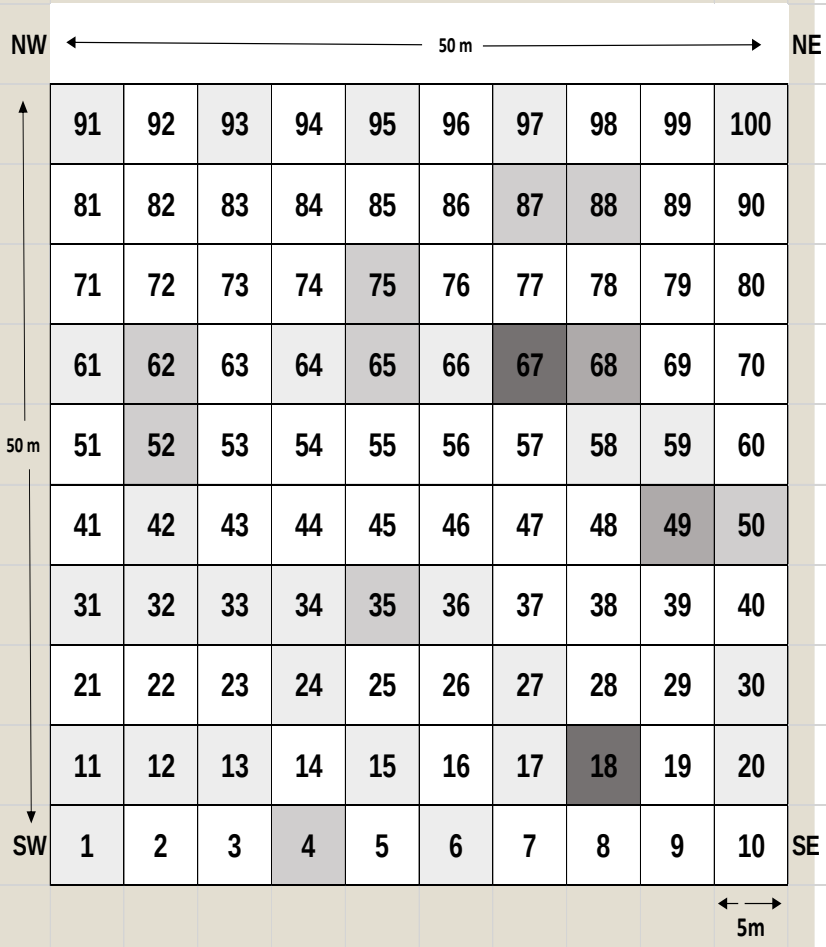
## LB Trail Plot - thickness of O horizon



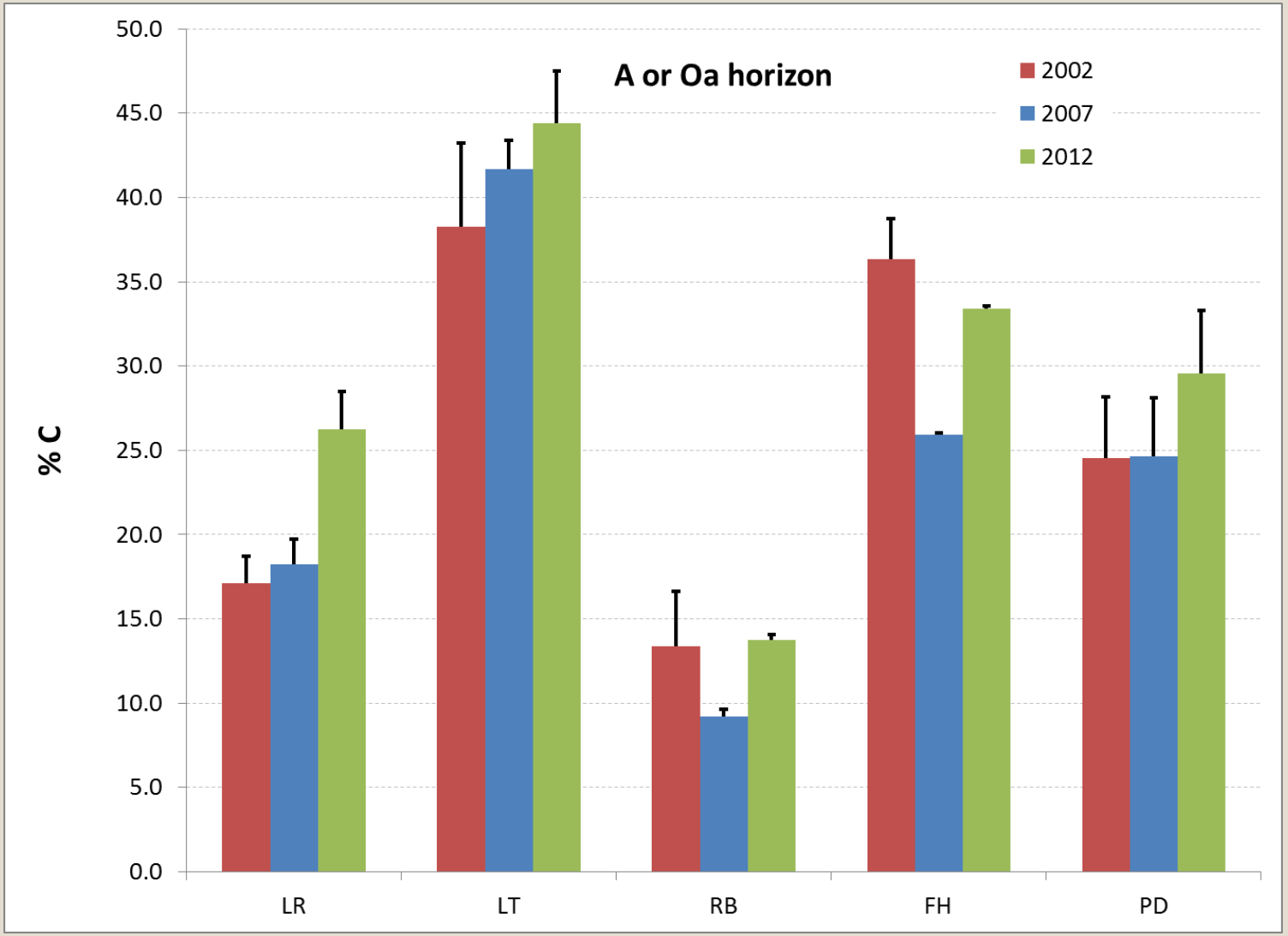




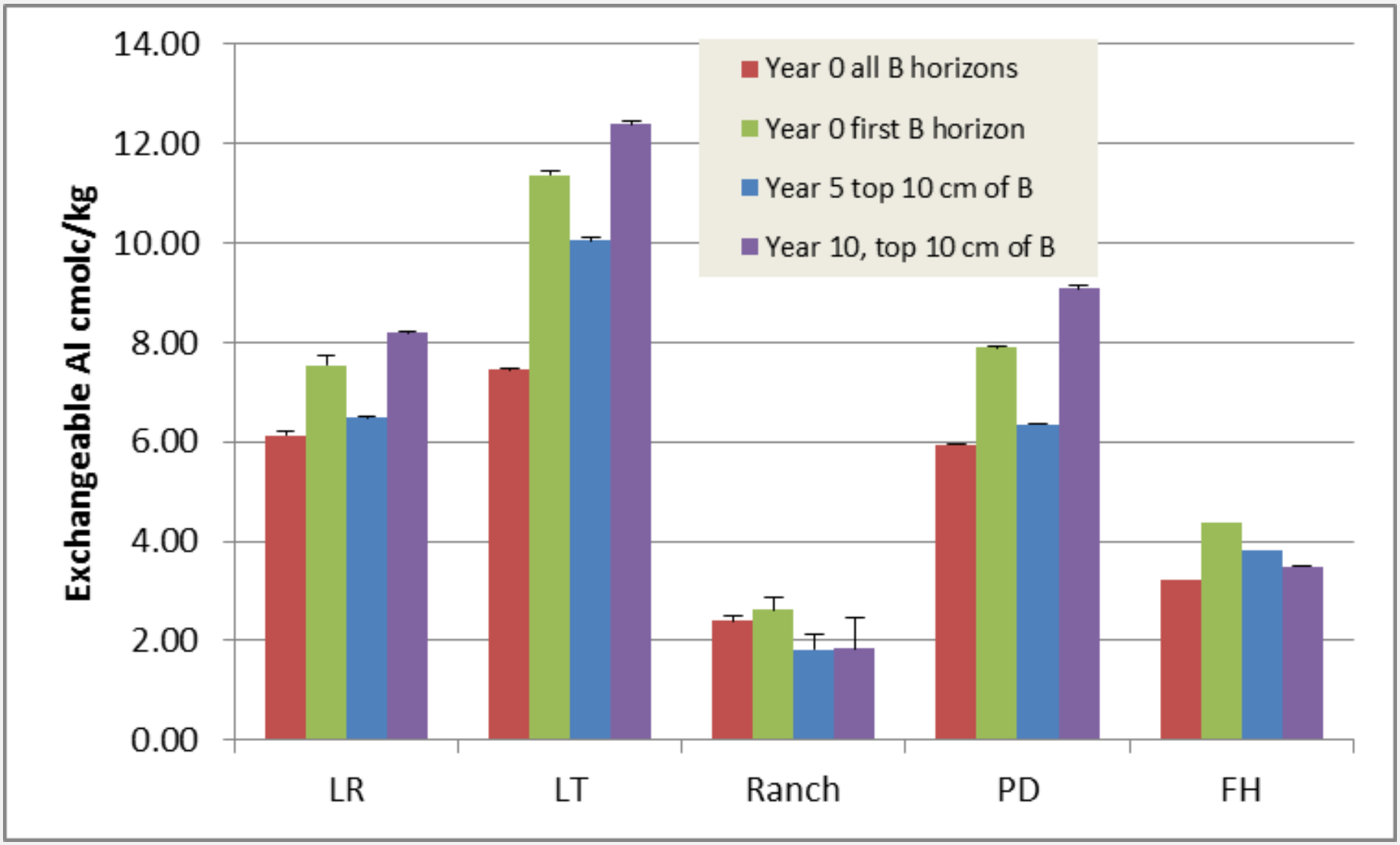
## MM Ranch Brook Plot - thickness of O horizon



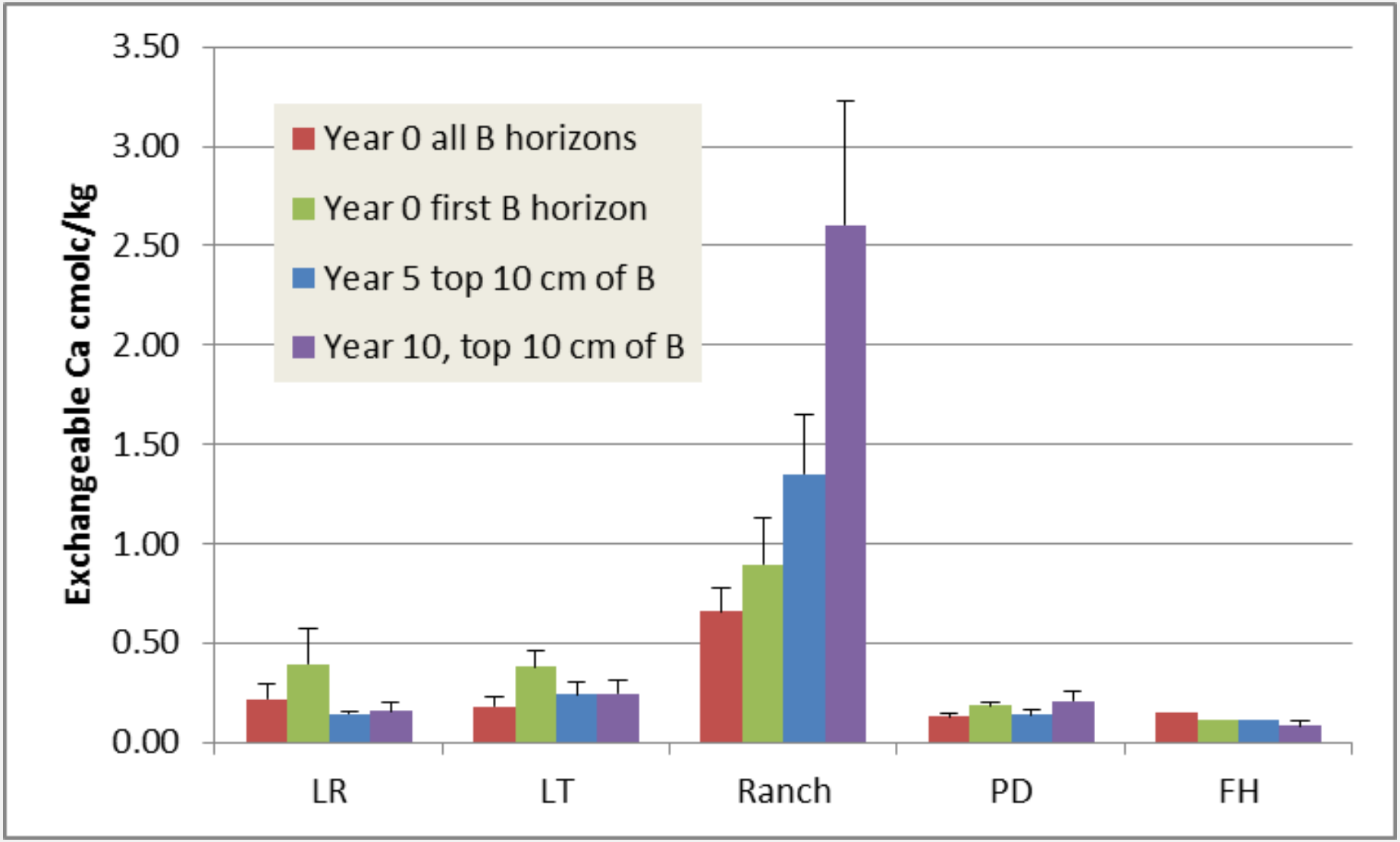
# Carbon in the Oa/A horizon



# Exchangeable Al in the B horizon



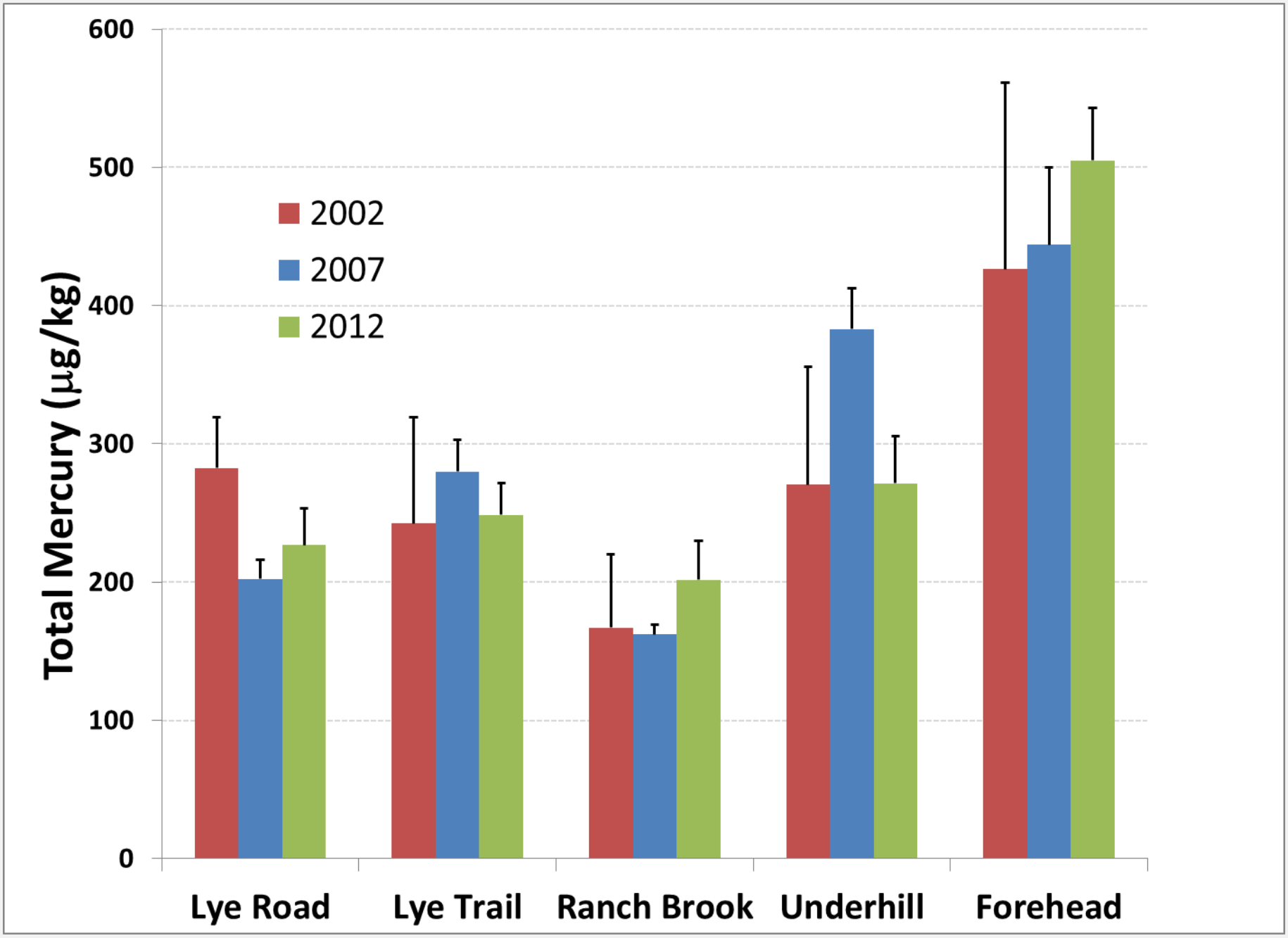
# Exchangeable Calcium in B horizons
## (Ranch Brook in class by itself)

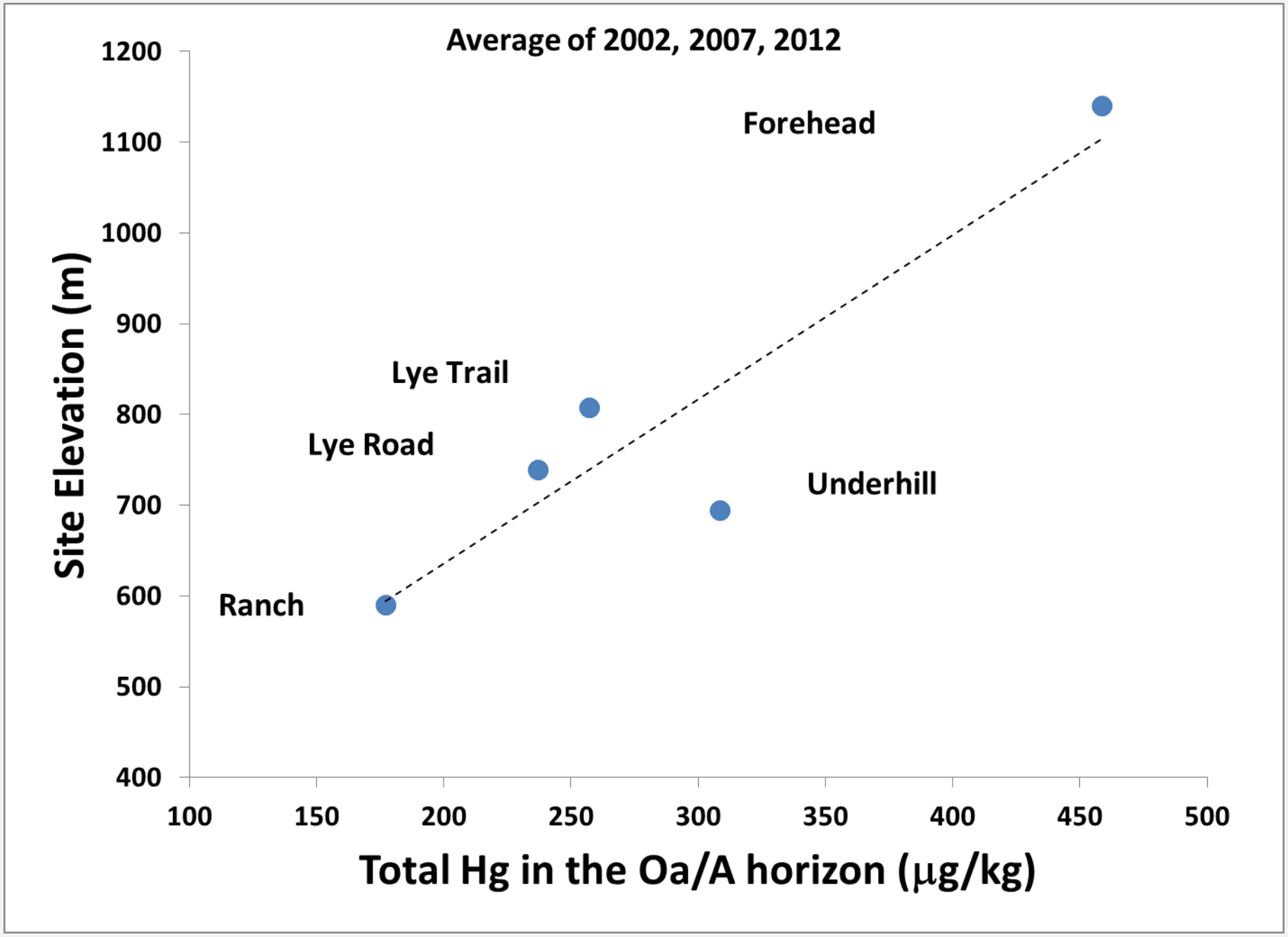


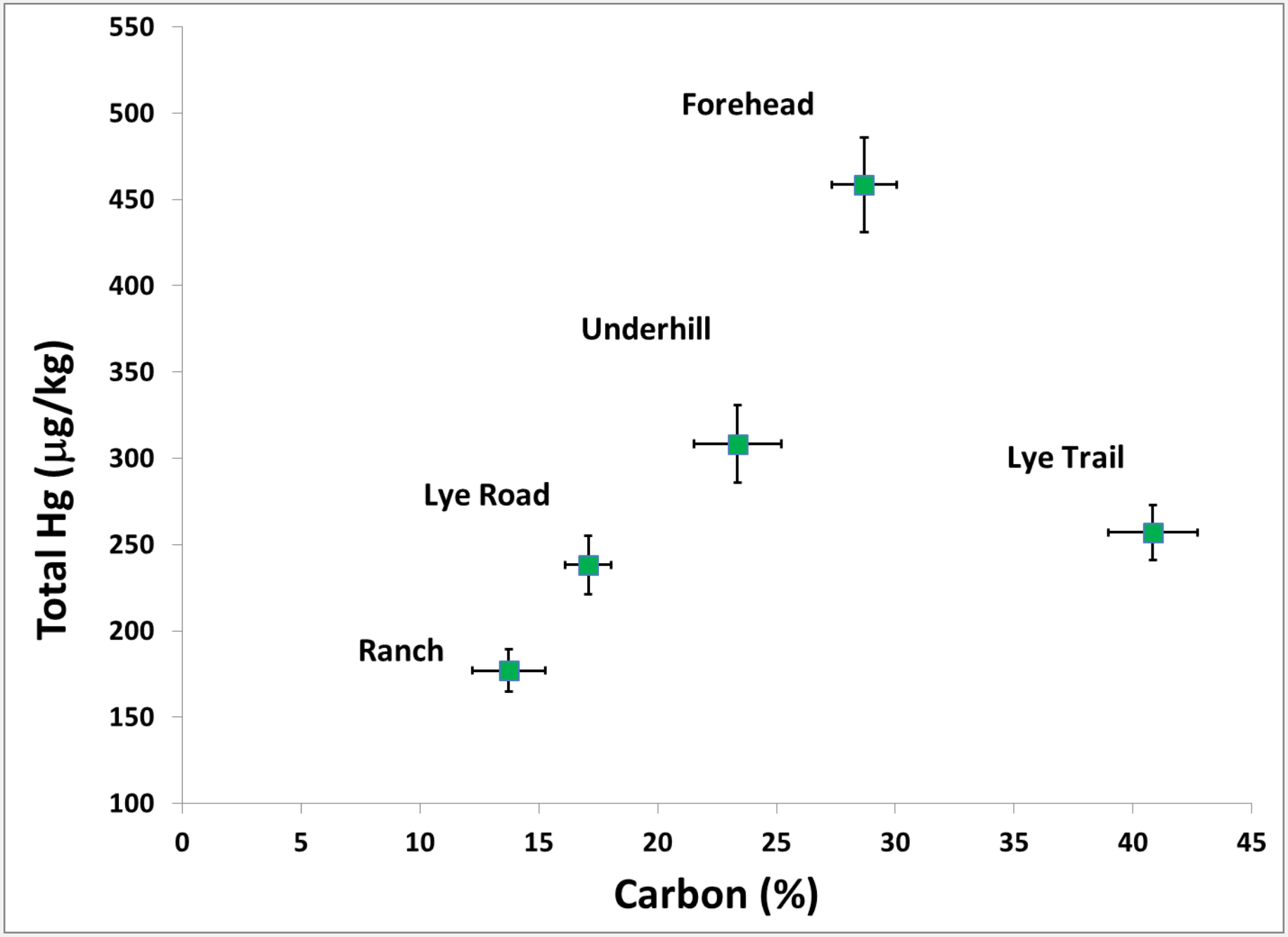
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 91 | 92 | 0.45<br>0:10 | 94 | 95 | 96 | 1.50<br>2:<1 | 98 | 99 | 1.85 |
| 81 | 82 | 83 | 84 | 85 | 86 | 3.71<br>3:<1 | 3.69<br>4:<1 | 89 | 90 |
| 71<br>71 | 72 | 73 | 74 | 0.74 | 76 | 77 | 78 | 79 | 80 |
| 61 | 0.31<br>0:2 | 63 | 0.34<br><1:9 | 0.78 | 2.46 | 3.01<br>1:4 | 1.51<br>1:9 | 69 | 70 |
| 51 | 0.74<br><1:3 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |
| 41 | 0.41<br><1:5 | 43 | 44 | 45 | 46 | 47 | 48 | 1.51<br>5:2 | 3.45<br>2:1 |
| 0.33 | 32 | 0.34 | 34 | 0.37 | 0.31<br>3:<1 | 37 | 38 | 39 | 40 |
| 21 | 22 | 23 | 24 | 25 | 26 | 2.66<br>4:1 | 28 | 29 | 2.98<br>3:2 |
| 11 | 0.55<br>3:5 | 0.44 | 14 | 15 | 16 | 0.72<br>3:1 | 1.72<br>2:3 | 19 | 0.93 |
| 0.46<br>1:7 | 2 | 3 | 0.70 | 5 | 1.31<br>4:1 | 7 | 8 | 9 | 10 |

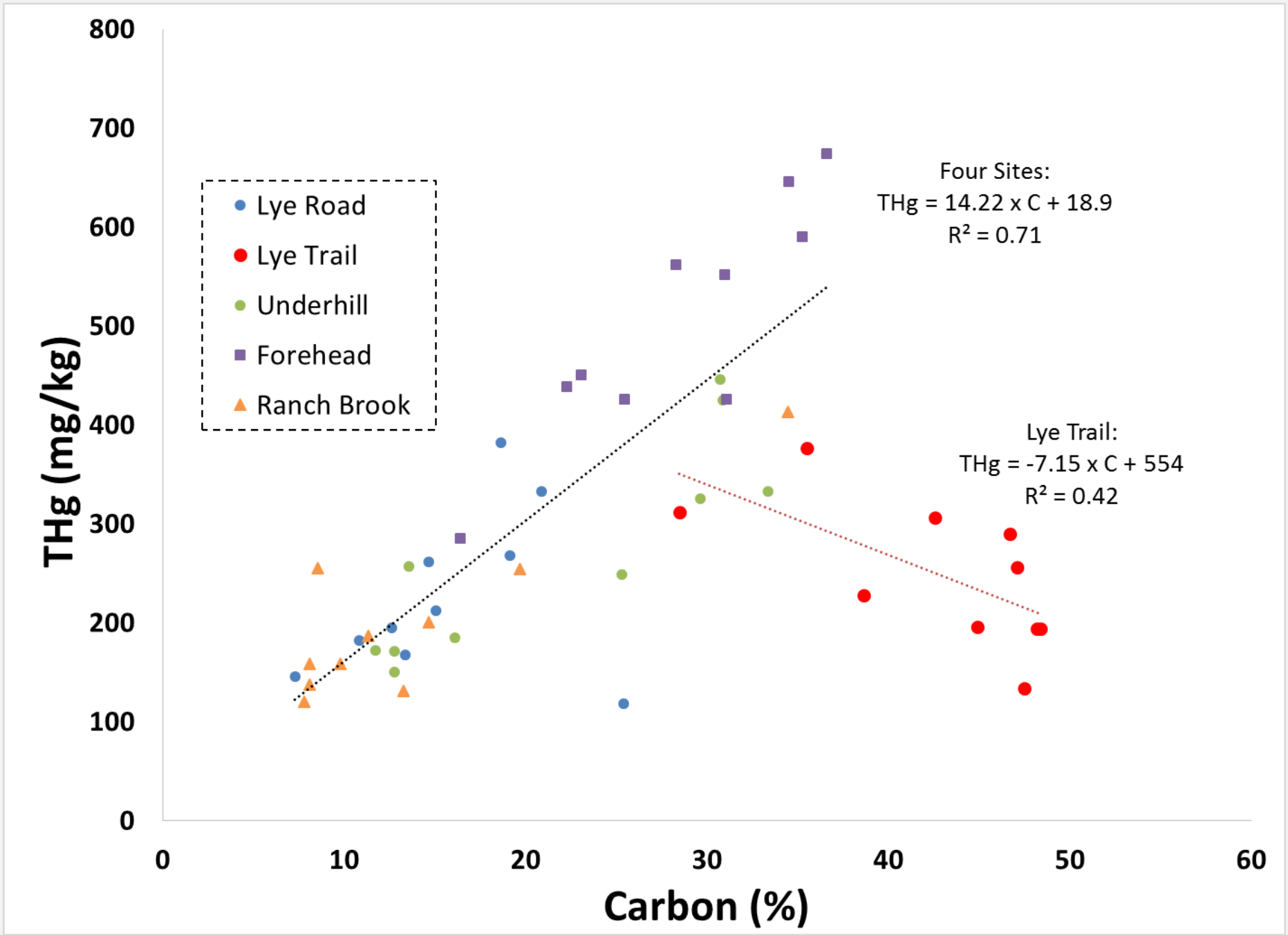
2002
2007
2012

Ratio is Sugar maple : yellow birch seedilings


600
500
400
300
200
100
0
Total Mercury (µg/kg)
2002
2007
2012
Lye Road
Lye Trail
Ranch Brook
Underhill
Forehead


Average of 2002, 2007, 2012
Site Elevation (m)
1200
1100
1000
900
800
700
600
500
400
100
150
200
250
300
350
400
450
500
Total Hg in the Oa/A horizon (µg/kg)
Forehead
Lye Trail
Lye Road
Underhill
Ranch


Forehead
Underhill
Lye Road
Lye Trail
Ranch
Total Hg (µg/kg)
Carbon (%)
550
500
450
400
350
300
250
200
150
100
0
5
10
15
20
25
30
35
40
45


800
700
600
500
400
300
200
100
0
THg (mg/kg)
0
10
20
30
40
50
60
Carbon (%)
Lye Road
Lye Trail
Underhill
Forehead
Ranch Brook
Four Sites:
THg = 14.22 x C + 18.9
R² = 0.71
Lye Trail:
THg = -7.15 x C + 554
R² = 0.42

# Challenges

- Variability!
- Archiving—still nothing permanent guaranteed
- People keep retiring!
- Funding difficult
  - Some funding through the Forest Service and the FEMC

Formerly the VERMONT MONITORING COOPERATIVE

LOG IN

FEMC

Search...

ADVANCED SEARCH

DATA MONITORING COOPERATIVE PRODUCTS & SERVICES ABOUT

PROJECT

# Long-term Soil Monitoring

**Data now available!**

OVERVIEW DATASETS CONTRIBUTORS DOCUMENTS/IMAGES

**Type**
Monitoring project

**Project Lead**

Scott Bailey +

Donald Ross +

Thomas Villars +

**Contributing Organizations**

Natural Resources Conservation Service USDA +

See all contributors

**Project Citation**

Bailey S., D. Ross, T. Villars. 2017. Long-term Soil Monitoring. FEMC. Can be found at: https://www.uvm.edu/femc/data/archive/project/long-term-soil-monitoring

**Links**

## PROJECT OVERVIEW

Collect soil samples at two forested sites in Vermont. Establish permanent plot markers. Analyze soil samples and publish the results.

## Objectives

Collect soil samples from long term soil monitoring sites. Detect changes in soils due to human caused impacts (i.e. climate change, air pollution, forest management) at two forested sites in Vermont.

## Dataset Availability

**Downloadable**: 6 datasets

**Description only**: 4 datasets

**By request**: 2 datasets

**In 2017,**
**the FEMC (previously VMC, …and VForEM)**
**Vermont Long-term Soil Monitoring Project**
**Steering Team is:**

- Angie Quintana, USFS Green Mountain National Forest
- Jim Duncan, VT Forest Ecosystem Monitoring Cooperative
- Deane Wang, University of Vermont **(retired June 2017)**
- Sandy Wilmot, Vermont Dept. of Forests, Parks and Recreation **(retired January 2018)**
- Thom Villars, USDA Natural Resources Conservation Service **(retiring April 2018)**
- Don Ross, University of Vermont **(definitely retiring before 2022)**
- Scott Bailey, USFS Northern Research Station **(likely retiring before 2022)**

# (Almost) everyone involved in 2017:

- Sandy Wilmot, Vermont Forests, Parks and Rec
- Joshua Halman, Vermont Forests, Parks and Rec
- Isaac Estey, Vermont Forests, Parks and Rec
- Deane Wang, UVM
- Don Ross, UVM
- Emily Piersiak, UVM
- Liza Lemieux, UVM
- Jim Duncan, FEMC
- John Truong, FEMC
- Matt Gorton, FEMC
- Scott Bailey, US Forest Service, Northern Research Station
- Emily Piche, US Forest Service, Northern Research Station (now UVM)
- Angie Quintana, US Forest Service, GMNF
- Josh Lobe, US Forest Service, GMNF
- Thom Villars, NRCS-VT
- Alexis Clune, NRCS-VT
- Vermont Youth Conservation Corps (8 crew members)

**Funding generousy provided by FEMC and Green Mountain and Finger Lakes National Forests**

**Thanks Thom!**
**(retirement imminent)**