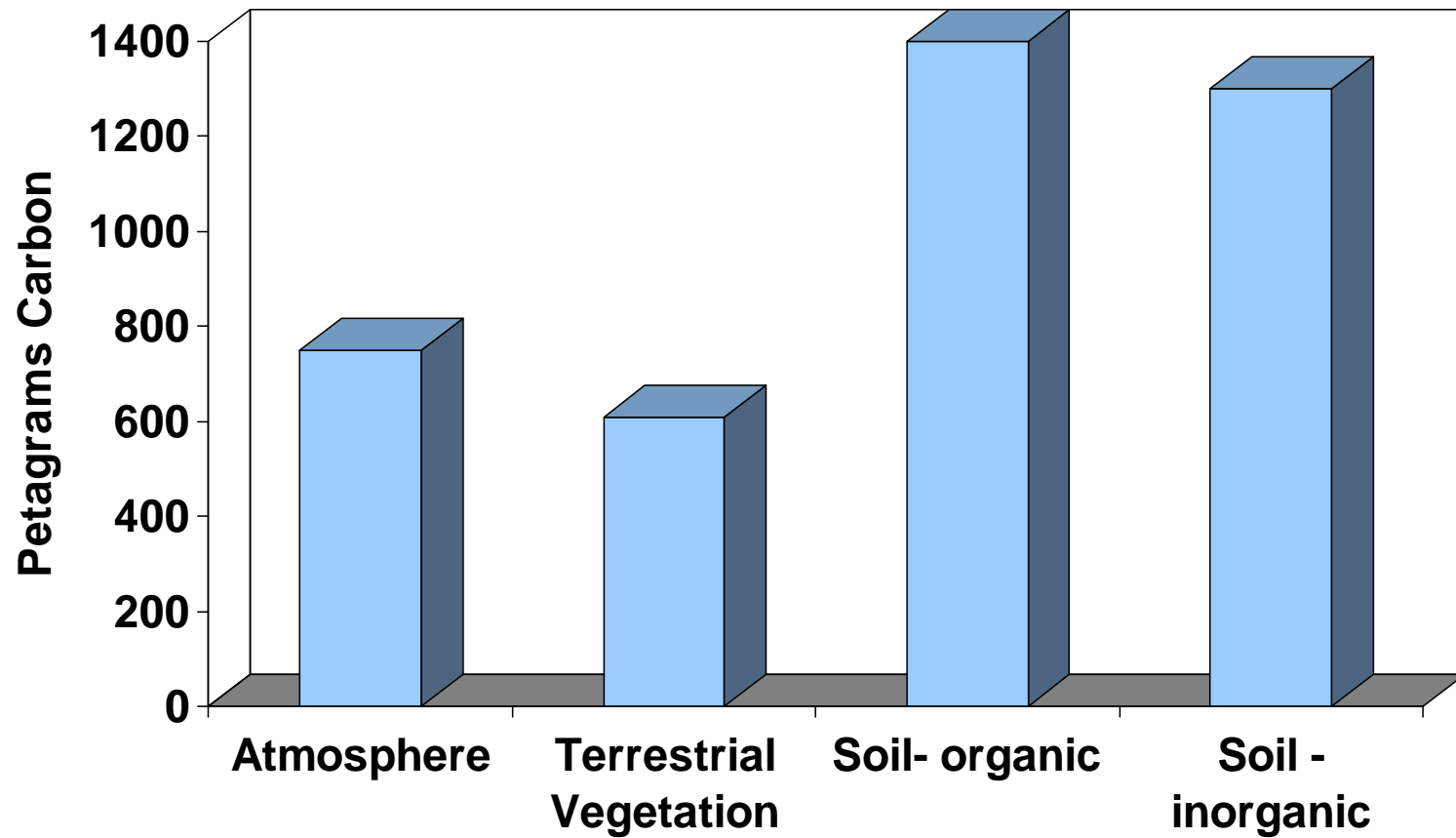


Estimating Vermont's Forest Soil Carbon Stock

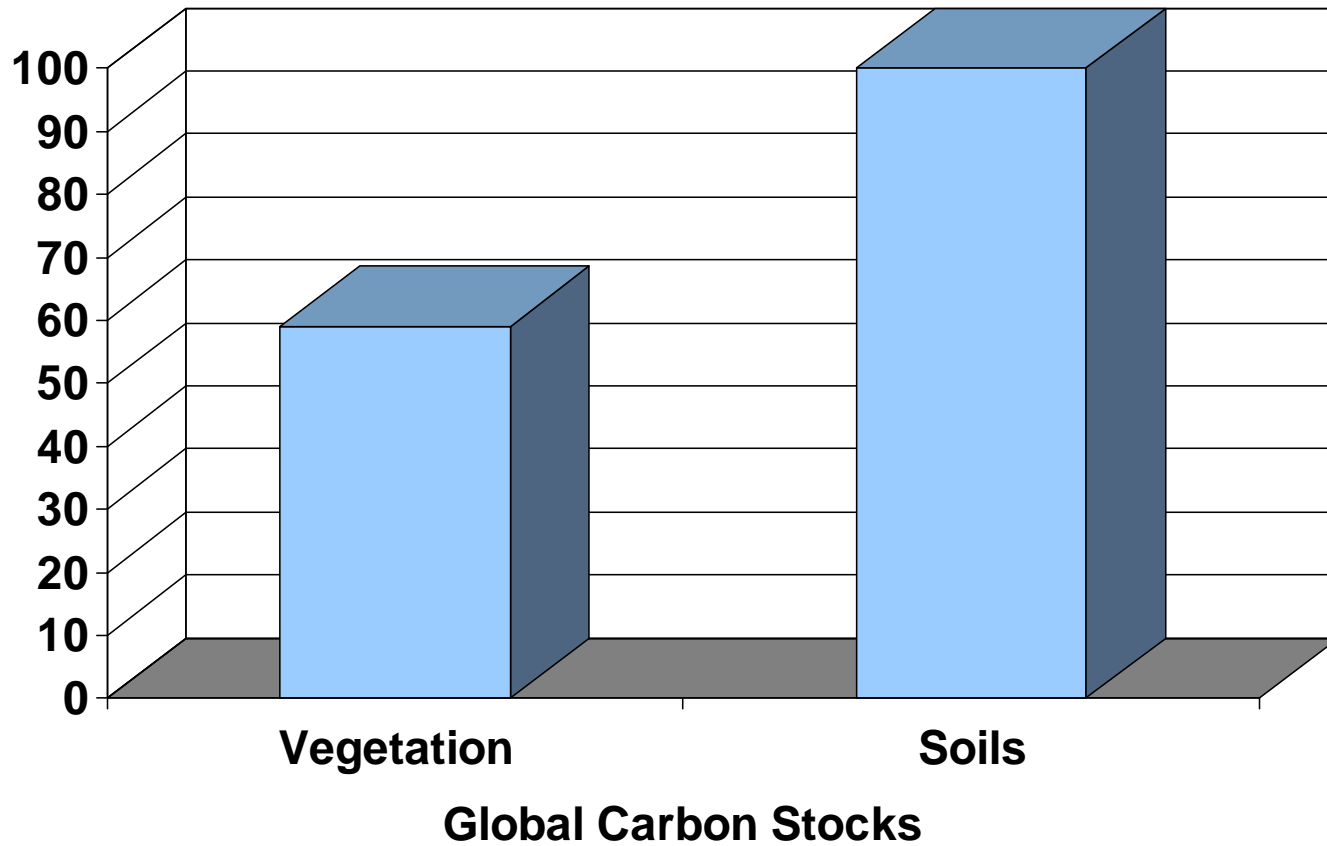
*Sandy Wilmot, VT Forestry Division
Thom Villars & Martha Stuart, NRCS
Juliette Juillerat & Don Ross UVM
Erik Engstrom, VT GIS-IT*

Global Carbon Stock



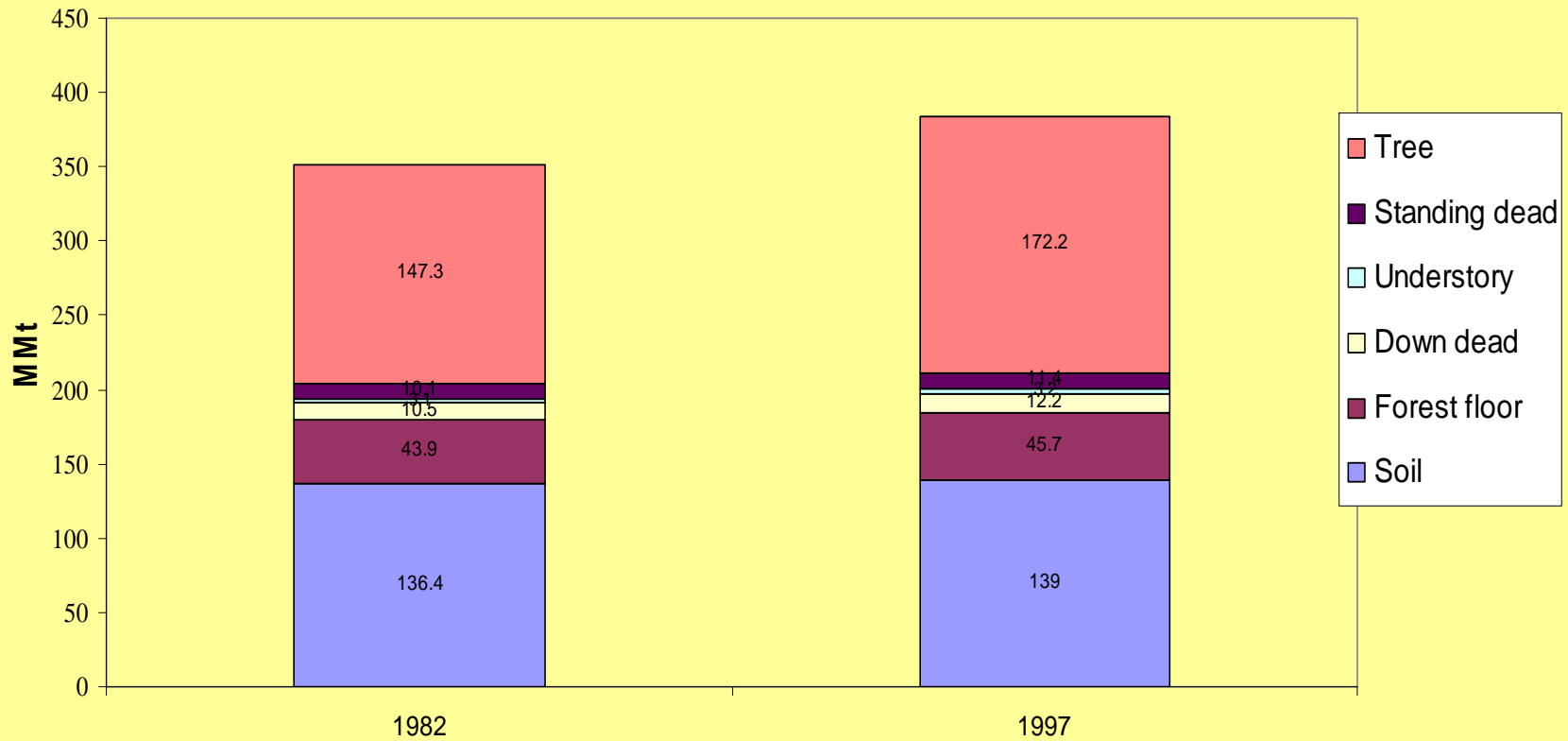
Kimble et al. 2003

Temperate Forest Carbon Pools



Vermont Forest Carbon Inventory, 1992 & 1997

Governor's Commission on Climate Change Report



Forest Inventory & Analysis (FIA)

Vermont Forests As Sink For Carbon

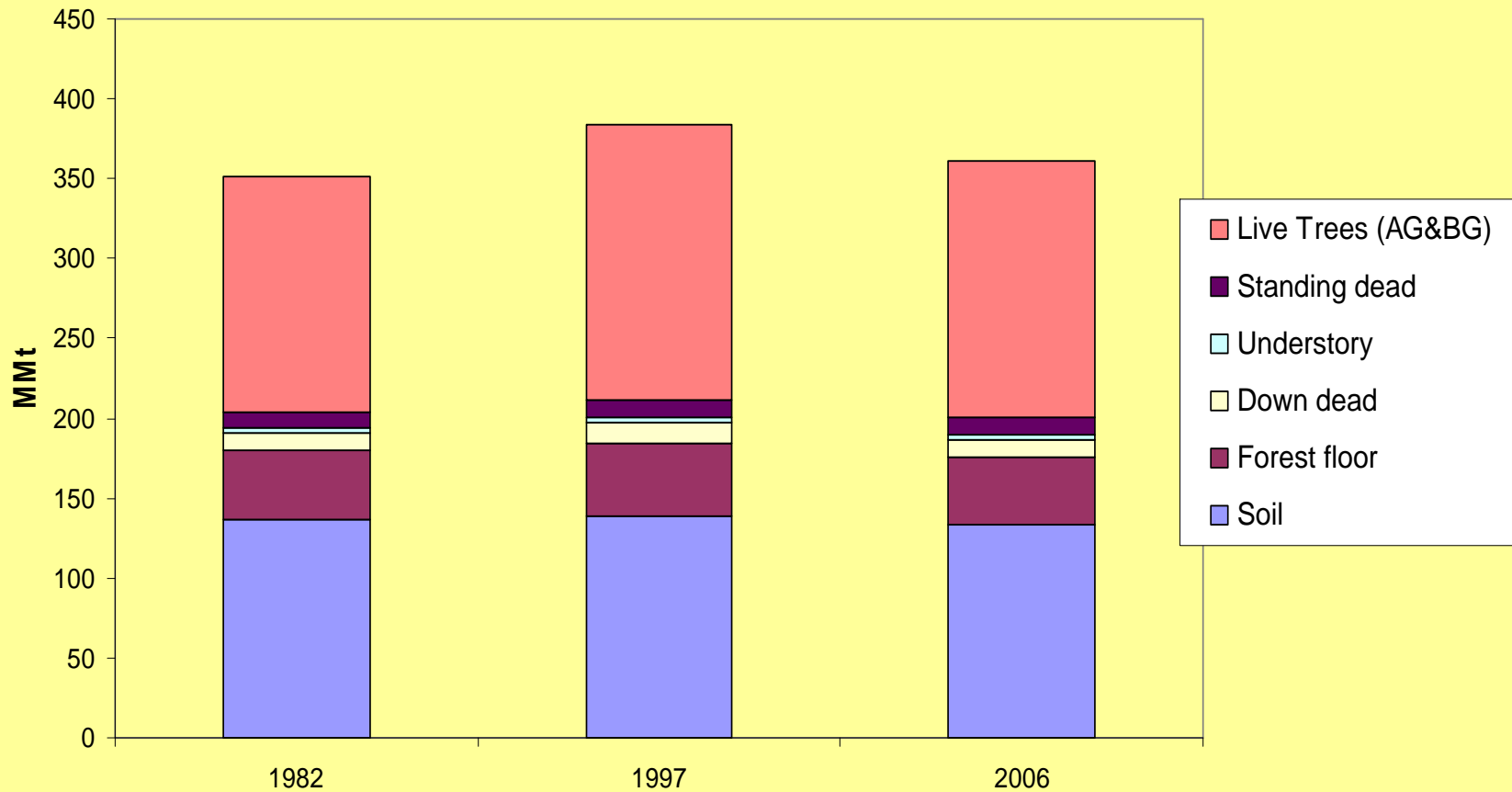
Governor's Commission on Climate Change



<u>Carbon Accumulation</u>	<u>MMtCO₂e /yr</u>
<i>Live Trees</i>	<i>-6.3</i>
<i>Standing Dead Trees</i>	<i>-0.3</i>
<i>Live Understory</i>	<i>-0.03</i>
<i>Dead and Down Trees</i>	<i>-0.4</i>
<i>Forest Floor</i>	<i>-0.5</i>
<i>Soils</i>	<i>-0.7</i>
<i>Harvested Wood Products</i>	<i>-1.4</i>
TOTAL	-9.63

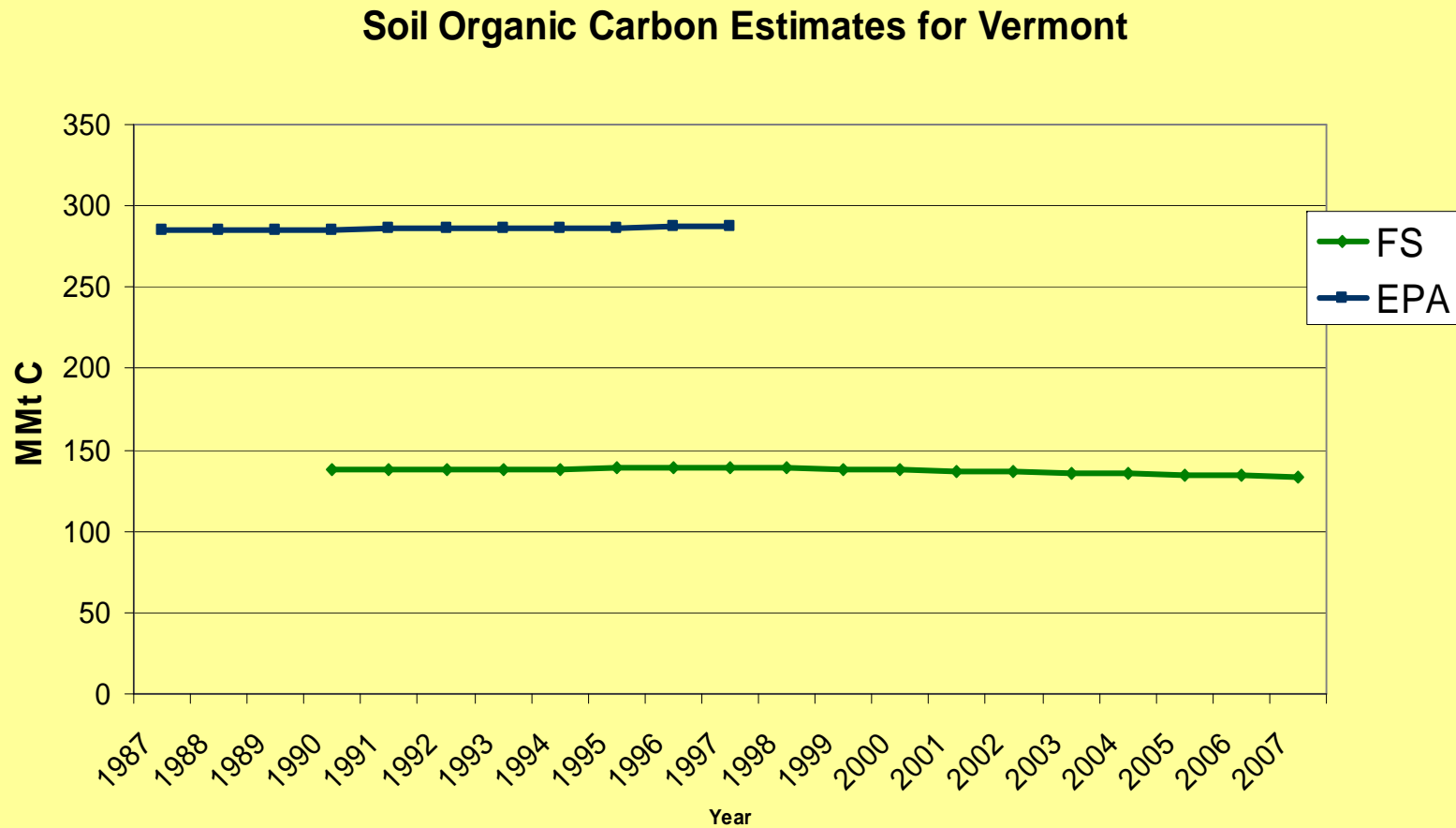
Updated Forest Inventory through 2006

1997 to 2006: Decrease in total carbon (383.7 to 360.7 MMt)



Forest Inventory & Analysis (FIA)

Difference between Forest Service and Environmental Protection Agency soil carbon estimates ...



Soil Carbon Inventory Project

UVM Class Project: Improve forest soil carbon estimates for Vermont using local GIS data.

- Juliette Juillerat, UVM Graduate Student, PSS and William Warnock, UVM Student
- Martha Stuart and Thom Villars, NRCS

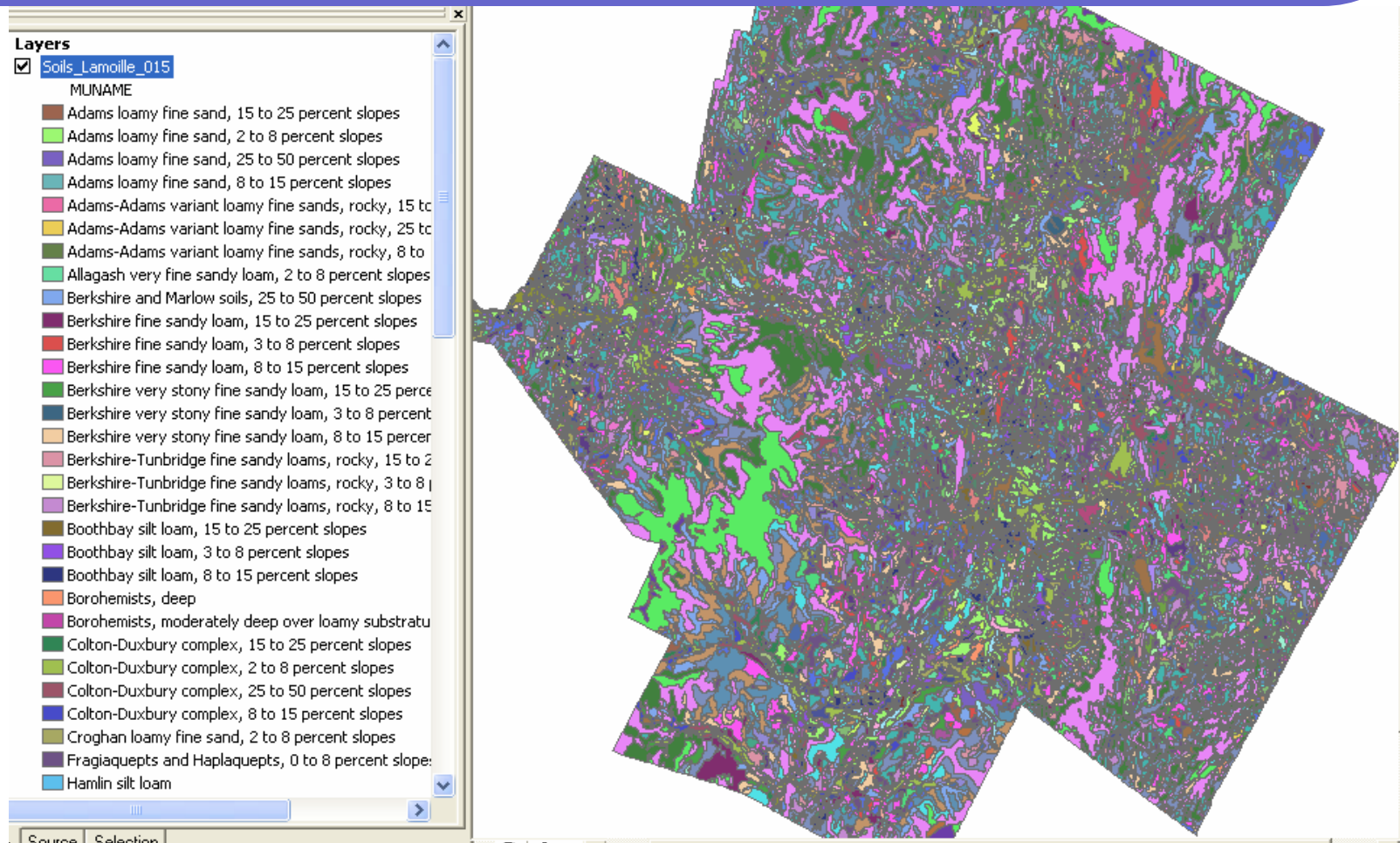


Can we develop a spatial model of Soil C?

- Landscape factors
- Soils data
 - Forest health monitoring program
 - Hardwood health survey
 - Vermont monitoring cooperative long-term soil plots
 - Lots of scattered research data

Not so easy ...

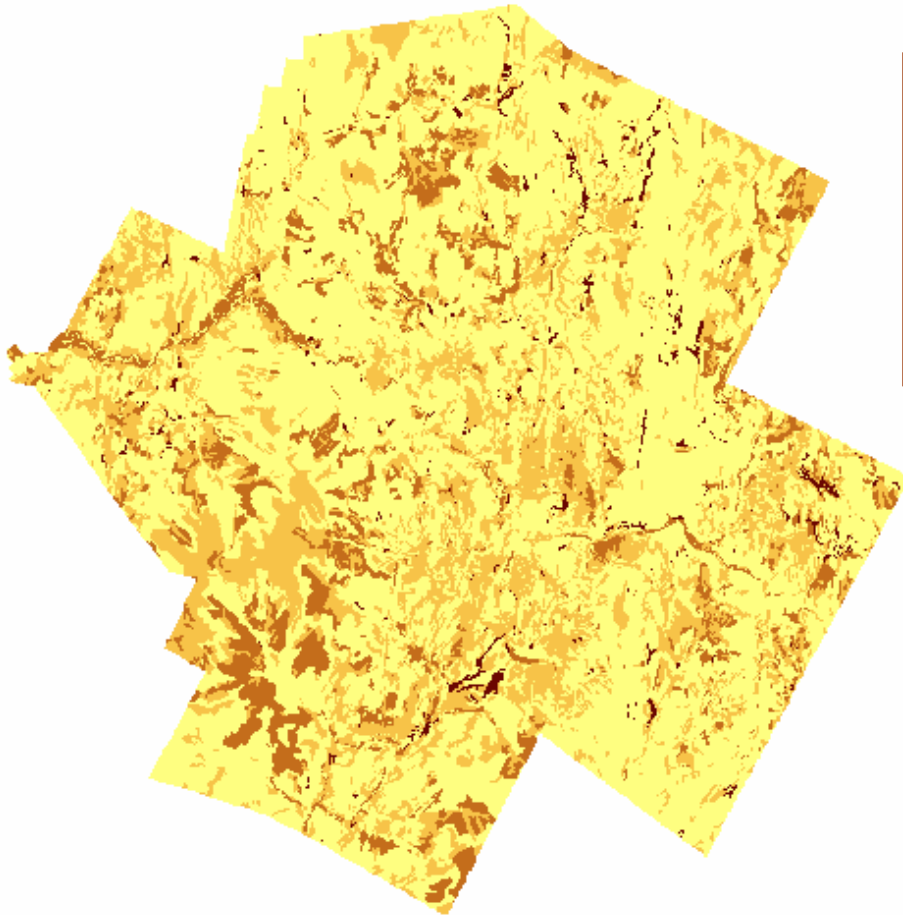
NRCS SSURGO - County Soil Data Layer: Soil series associated with individual polygons



Organic Carbon of Soil Polygons

NRCS NASIS Database

Organic matter % by map unit and horizon.
100 cm below duff layer or to bedrock.



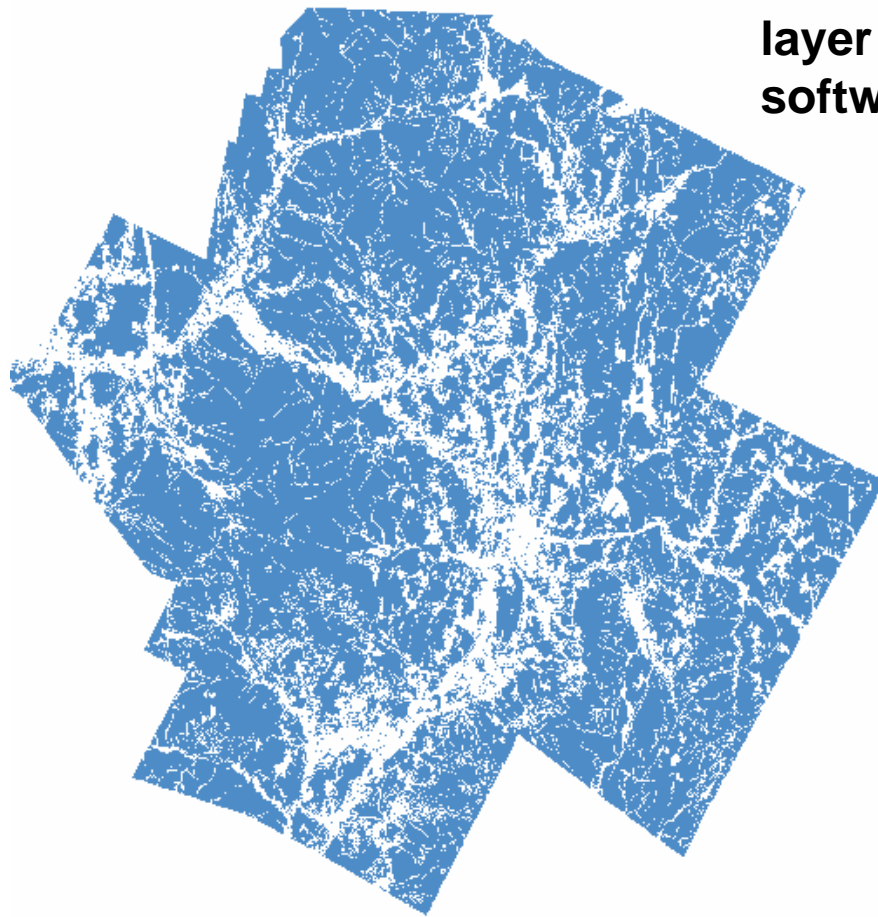
OM to SOC equation (National Soil Survey Lab, Lincoln, Nebraska)

OC horizon = $58 \times (\%OM \times \text{bulk density} \times (\text{fine particle-p}/100))$

OC sum = SUM (horizon thickness \times OC)

- Used “representative value” for each map unit.
- For soil complexes, weighted averages for each series was used.

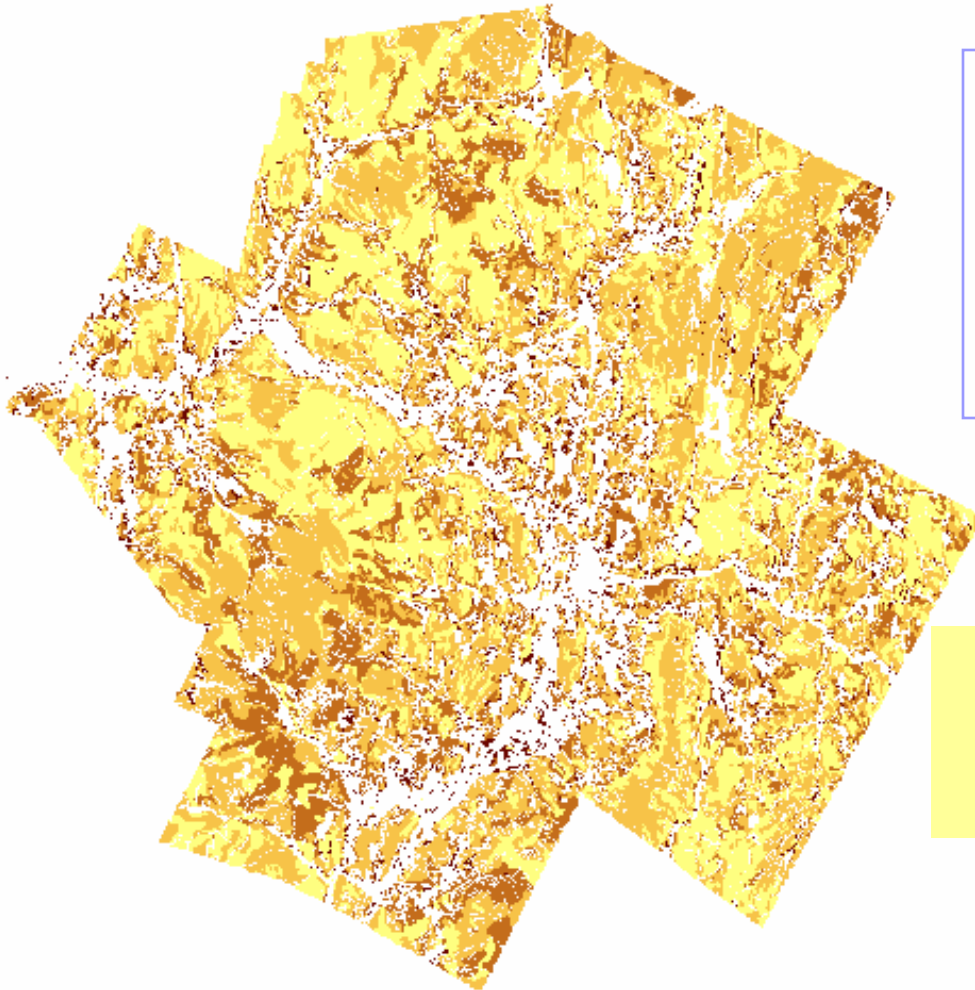
Forest Cover



**National Land Cover Data (2002)
layer used to determine hardwood,
softwood, and mixed forests**

Forest pixels then converted
from Raster to Polygon data,
and used to clip only those
soil polygons that are
forested.

Forest Soil Carbon For Lamoille County



Final steps are to determine the area of each forested map unit to calculate total soil carbon, then convert to metric tonnes.

Lamoille County
forest soil carbon =
15.3 MMTC

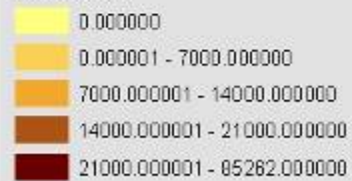
Vermont Forest Soil Organic Carbon



Soil Carbon (gms/m²)

VT_soilcarbon

wt_avg_rv

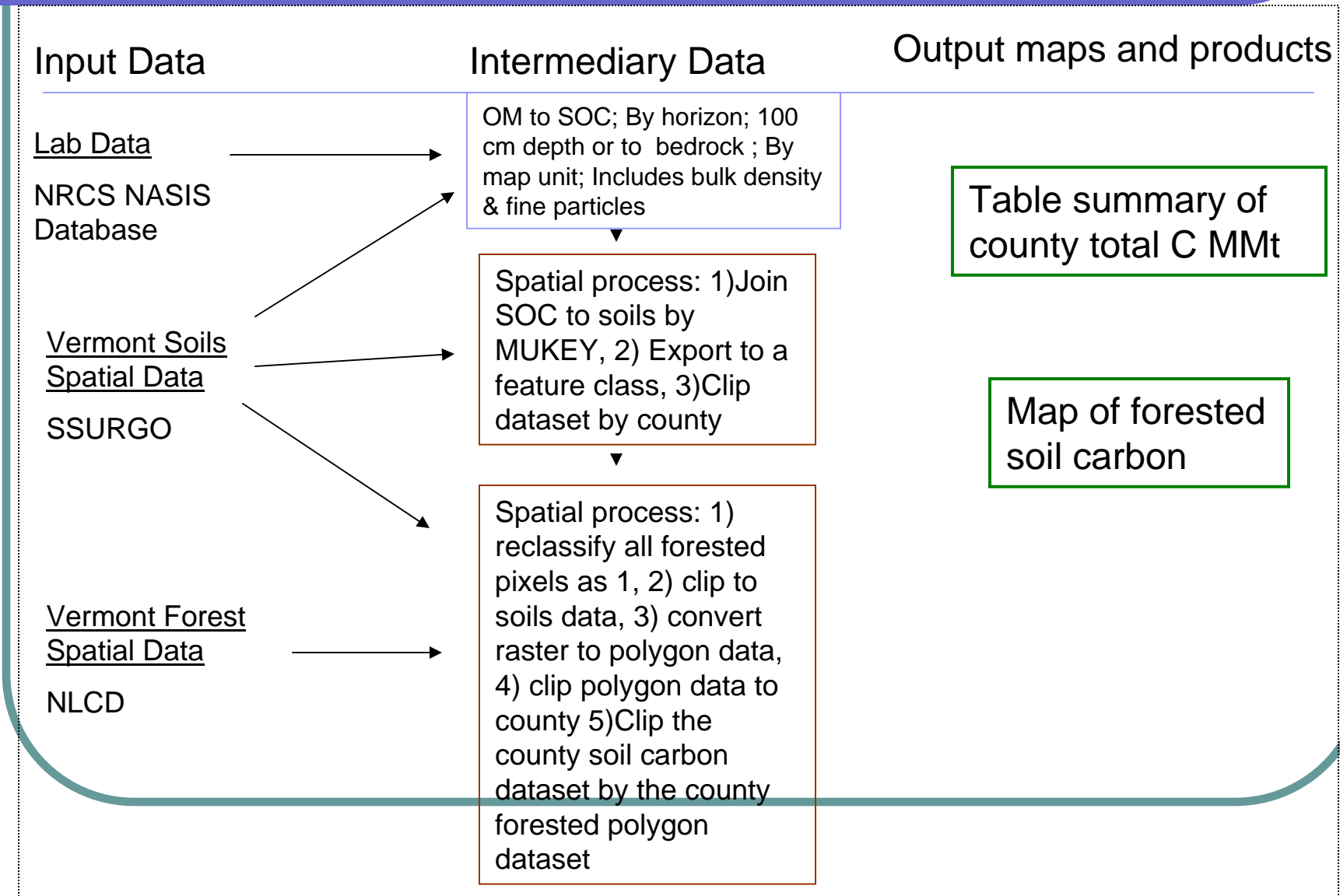


County	Forest Soil Carbon (MMt)
Addison	11.64
Bennington	15.26
Caledonia	14.19
Chittenden	8.30
Franklin	7.77
Grand Isle	1.38
Lamoille	11.35
Orange	16.11
Orleans	13.77
Rutland	17.57
Washington	9.87
Windham	21.73
Windsor	20.20
Total (without Essex)	169.16

Questions for soil scientists on forest management

- What forest management guidelines would you suggest to maintain or enhance soil organic carbon?
- Should we have unique soil carbon management guidelines for areas of high soil carbon?
- What about areas that have low soil carbon?
- Any suggestions for cost effective ways to measure forest soil carbon for cap and trade offset programs?

Process



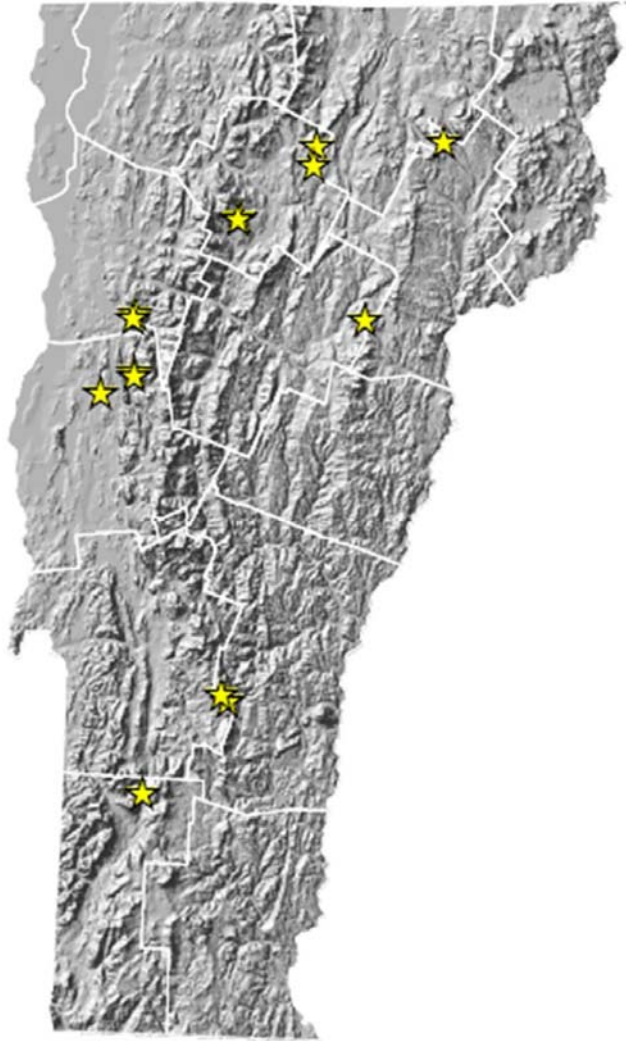
Another Soil Carbon Project

Soil Carbon and Other Quality Indicators in Managed Northern Forests

- Don Ross, UVM
- Sandy Wilmot, VT Dept. Forests...
- Juliette Juillerat, UVM Graduate Student
- Many state and federal partners

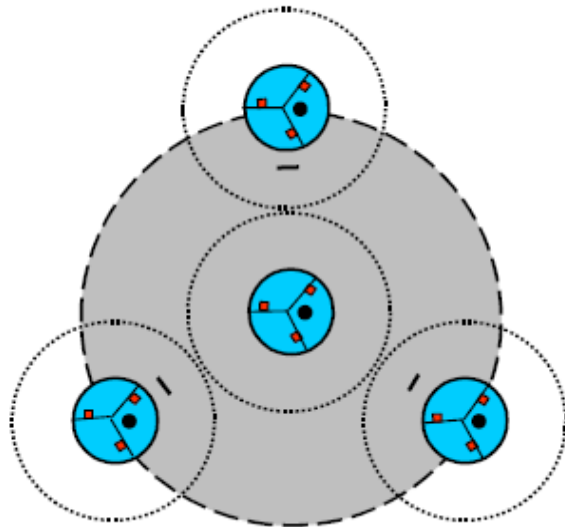


Establishing reference plots on sites that have a management plan



Using the FIA plot design but digging three pits and taking six cores

Phase 2/Phase 3 Plot Design



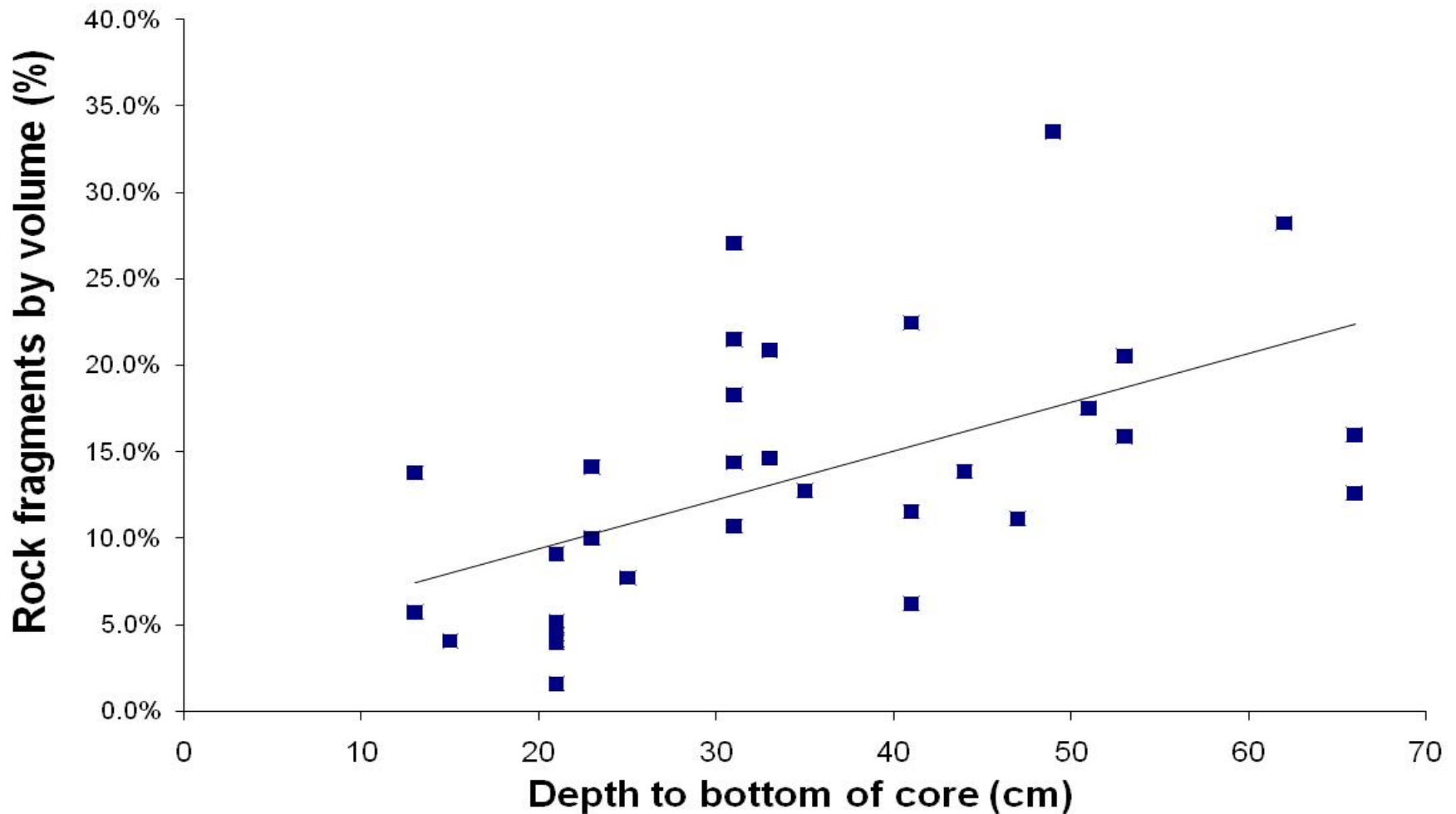
● Subplot	24.0 ft (7.32 m) radius
● Microplot	6.8 ft (2.07 m) radius
○ Annular plot	58.9 ft (17.95 m) radius
● Lichens plot	120.0 ft (36.60 m) radius
■ Vegetation plot	1.0 m ² area
— Soil Sampling	(point sample)
— Down Woody Debris	24 ft (7.32 m) transects



Diamond-tipped 3" (7.6 cm) corer mounted on a post auger

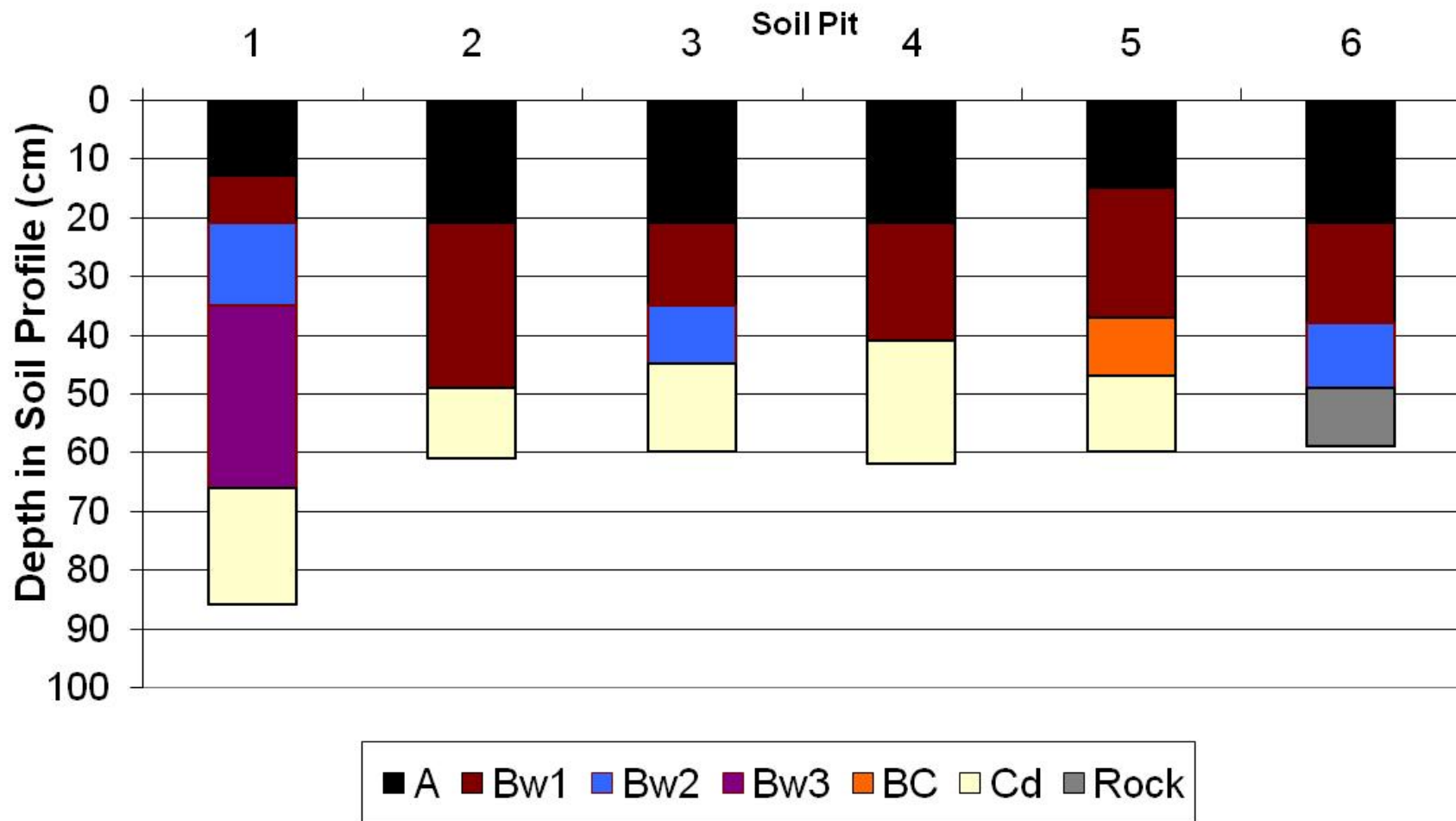


Corer allows direct measurement of rock fragments and bulk density



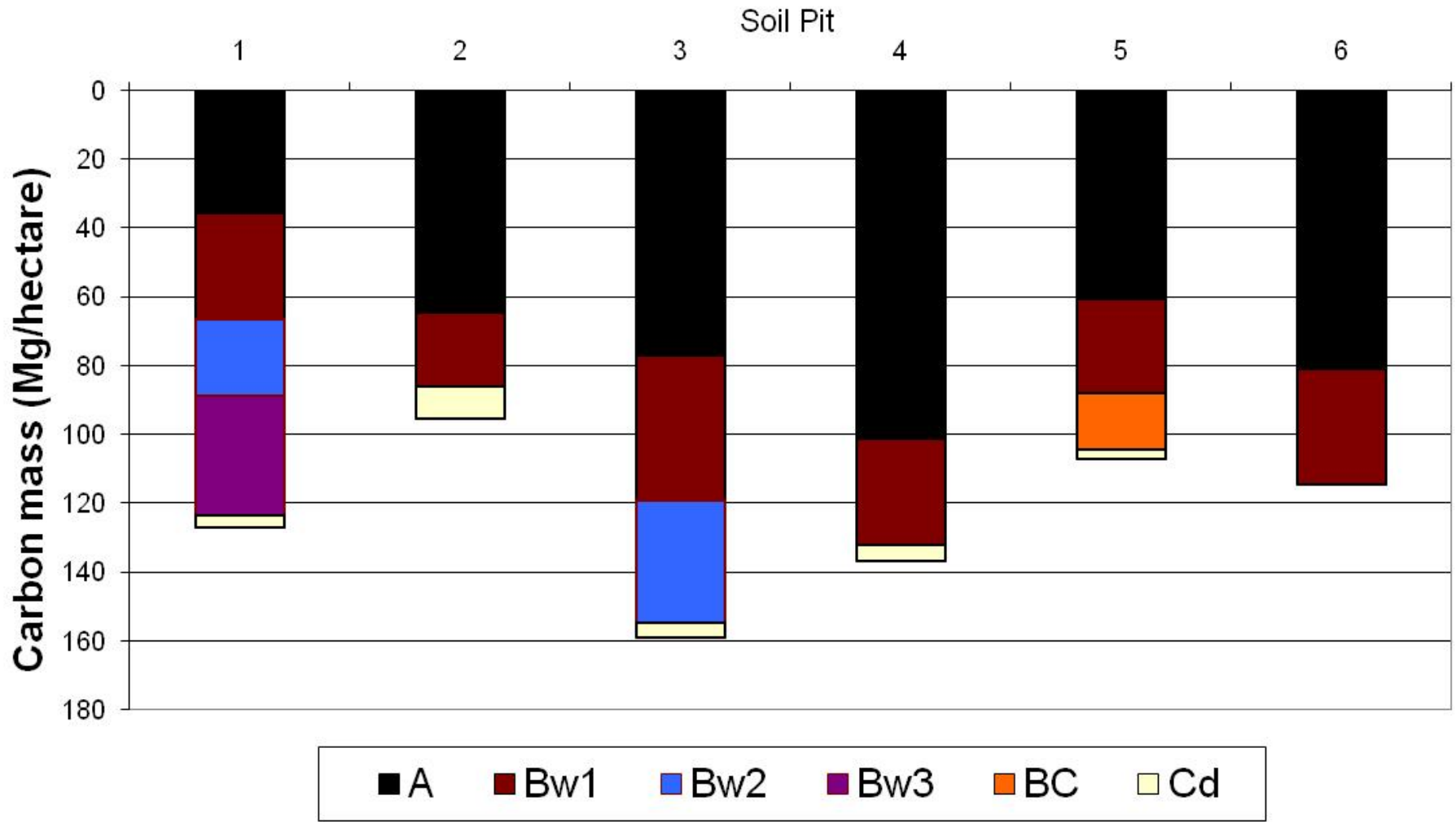
Horizon Depth by Soil Pit

Six profiles from the Hinesburg Town Forest



Carbon Mass by Soil Pit and Horizon

Six profiles from the Hinesburg Town Forest



Plot in Hinesburg Town Forest (relatively recent reforestation)

% Carbon by Soil Depth
Six profiles from the Hinesburg Town Forest

