Carbon Storage and Potential for Emissions Offset in the Long Lane Forest

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Research Forests: Tackling the problem of increased anthropogenic CO_2 emissions

Goal 1: Wesleyan shall achieve carbon neutrality for all greenhouse gas emissions before 2035.

Wesleyan committed to a 2050 carbon neutrality date in 2007 and now will accelerate its response to the global and local climate emergency in response to a 2018 United Nations report, which found that global carbon dioxide emissions need to fall 45 percent by 2030 to limit global warming to 1.5°C. By moving towards carbon neutrality as rapidly as possible through limiting and eventually eliminating fossil fuel emissions, Wesleyan will do its part to mitigate the impact of climate disasters on its campus, its students, and its community. The minimum cost for such a transition is $100 million.

Image Source: Wesleyan's Sustainability Strategic Plan, 2020

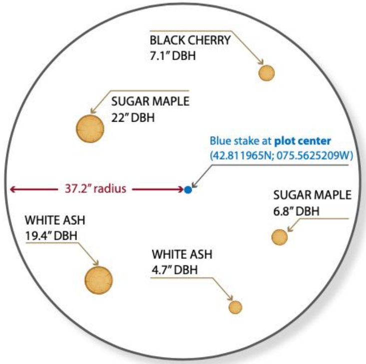


Image Source: Colgate University Forest Carbon Inventory and Projections, 2018

Image Source: Joel Labella, Drone Image of LLF, 2020

Connecticut and Long Lane Forest History

Image Source: Connecticut Forest and Park Association

Image Source: Long Lane Farm, Wesleyan University, 2018

Field Component

- Plot setup
  - DBH sampling / tree identification
  - Soil sampling
    - Bulk density
    - % Carbon

Tree Tag on a red maple in Plot C

Xavier Lopez taking soil sample for % carbon
(Image by Phil Resor)

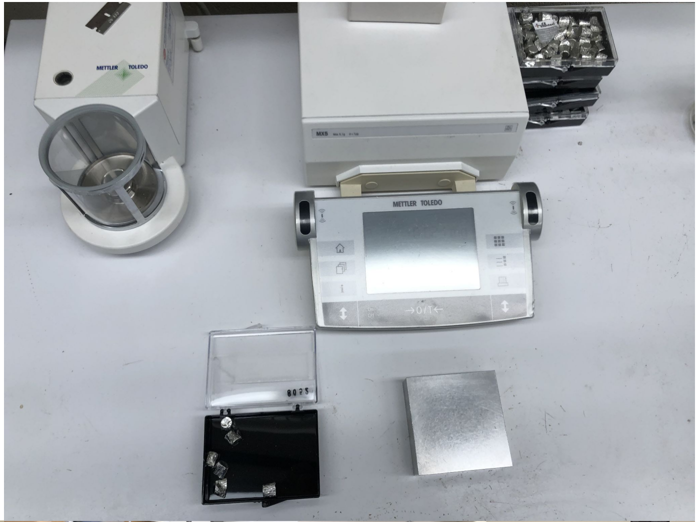
Soil auger for bulk density

Laboratory Component

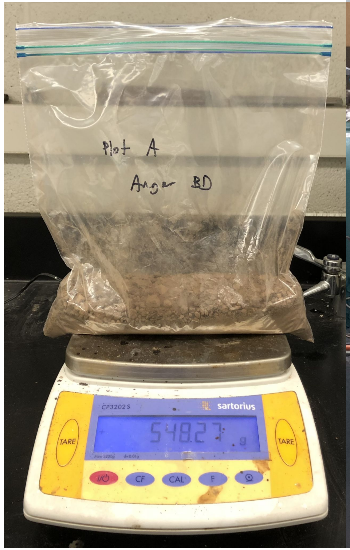
- Tree carbon equation (Jenkins, 2004)

$$biomass = e^{(\beta_0 + \beta_1(\ln(DBH))}$$

- Soil calculations
  - Bulk Density
  - %C



Microbalance and tin capsules for soil analysis



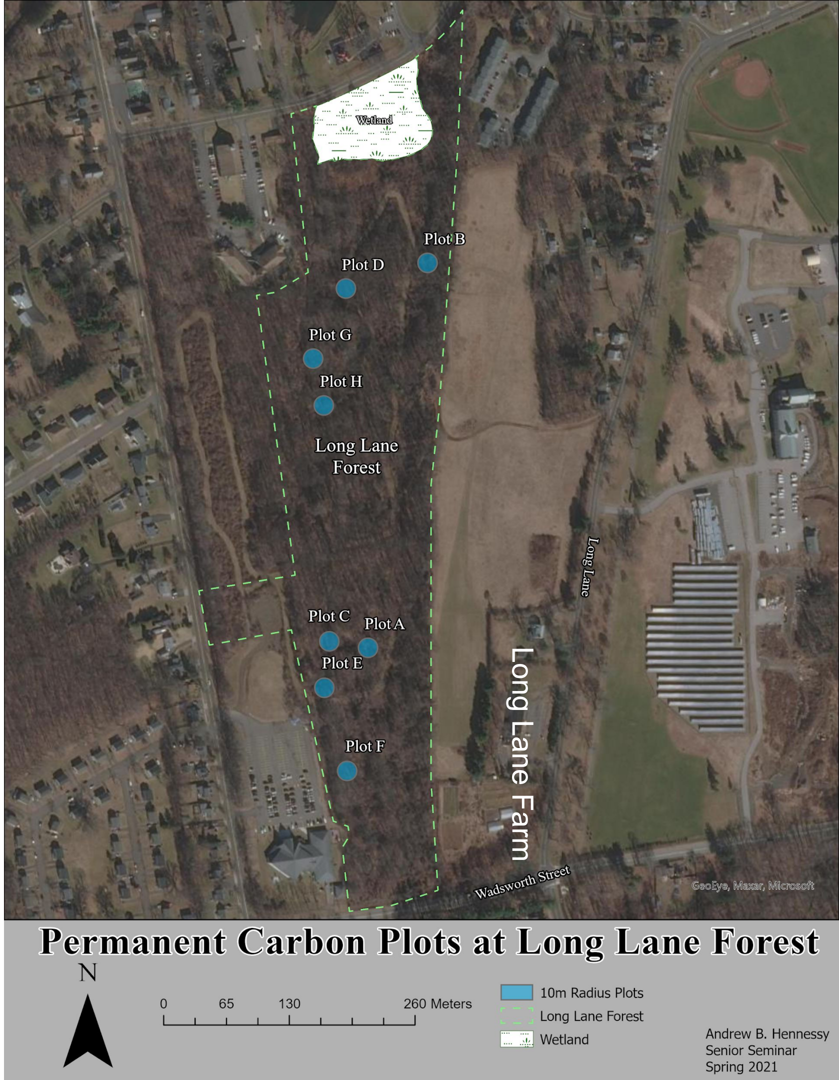
Soil for bulk density calculation from Plot A

Elemental Analyzer in Limnology Lab

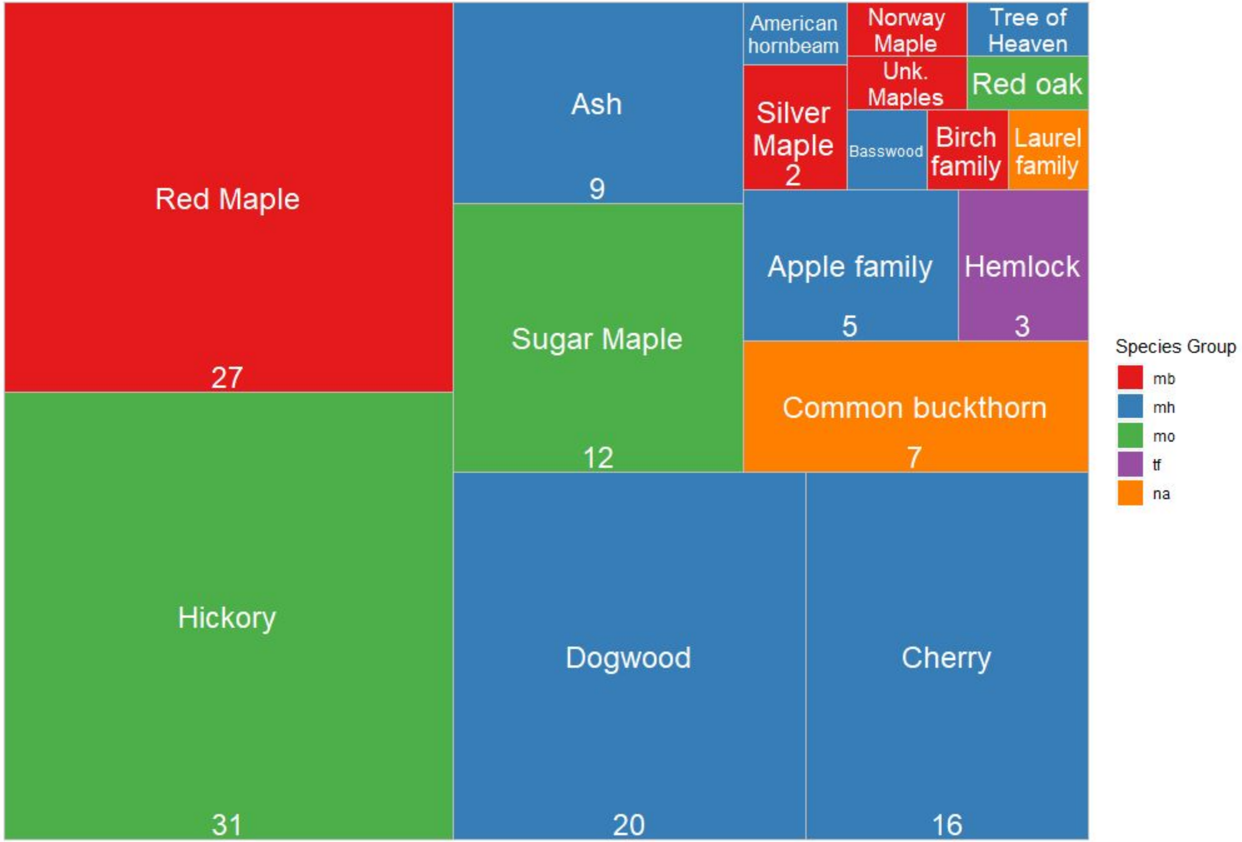
Permanent Carbon Plots

Summary Statistics for Trees in the Sample

Plot	Tree Count	Mean DBH (cm)	Mean Carbon (kg)	Sum Carbon (kg)
A	19.00	15.16	56.51	1,073.66
B	23.00	20.43	109.50	2,518.55
C	10.00	20.60	125.67	1,256.72
D	44.00	14.35	69.03	3,037.38
E	8.00	19.98	93.94	751.52
F	24.00	16.78	91.07	2,185.57
G	19.00	21.53	177.62	3,374.83
H	21.00	22.30	228.68	4,802.20
Total	168.00	18.07	119.00	19,000.44



Tree Species



Treemap showing the relative proportions of 140 identified trees. Numbers represent count of species in the sample, any unnumbered species only had 1 individual.

The groups follow the categories of Jenkins et al. (2004):
mb = soft maple / birch
mh = mixed hardwood
mo = hard maple / oak / hickory / beech
tf = true fir / hemlock
na = species not listed in Jenkins et al. (2004).

This figure excludes the 28 unidentified trees in our sample.

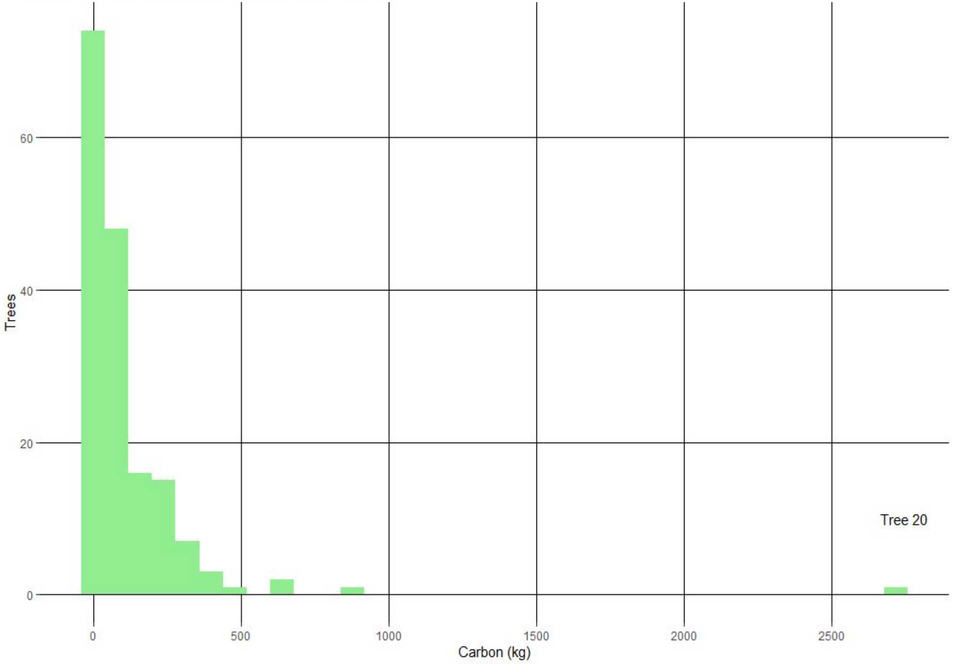
Understory Species

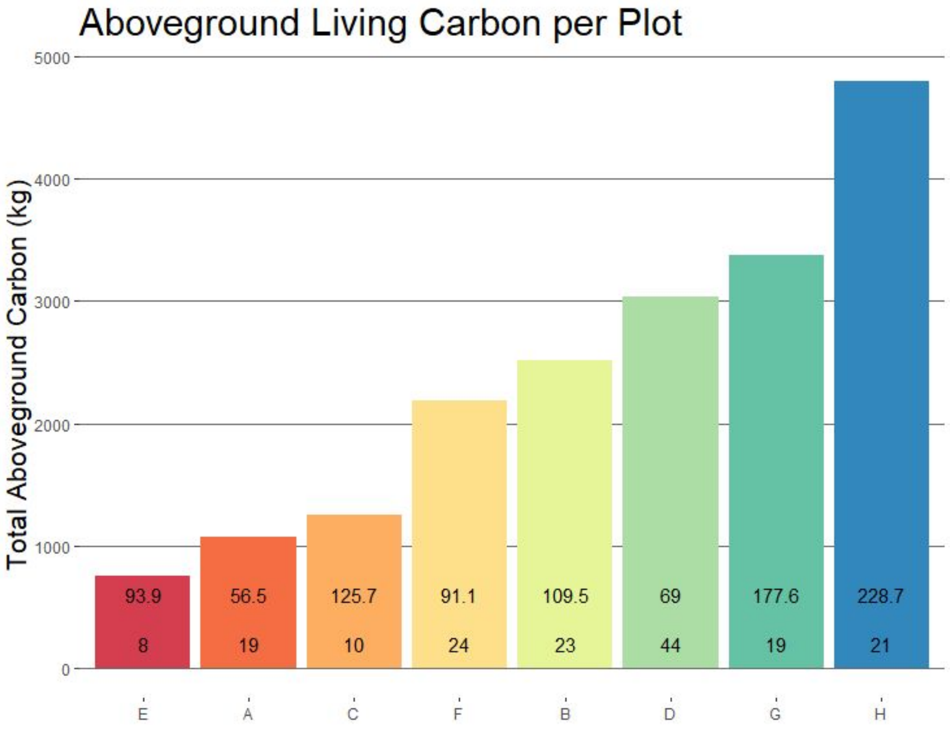
1: supplejack

The majority of understory plants are non-native

Distribution of Aboveground Carbon

The histogram (80kg bins) shows the distribution of carbon per tree in our entire sample, while the bar chart compares total and mean aboveground carbon per plot.





The bar numbers are tree count (bottom) and mean carbon per tree (top)

Tree 20 is the largest tree in our sample, a Red Maple with a DBH of 85.6

The majority of our trees contain between 0-160 kg of aboveground carbon, adding to a total of ~19,000 kg.

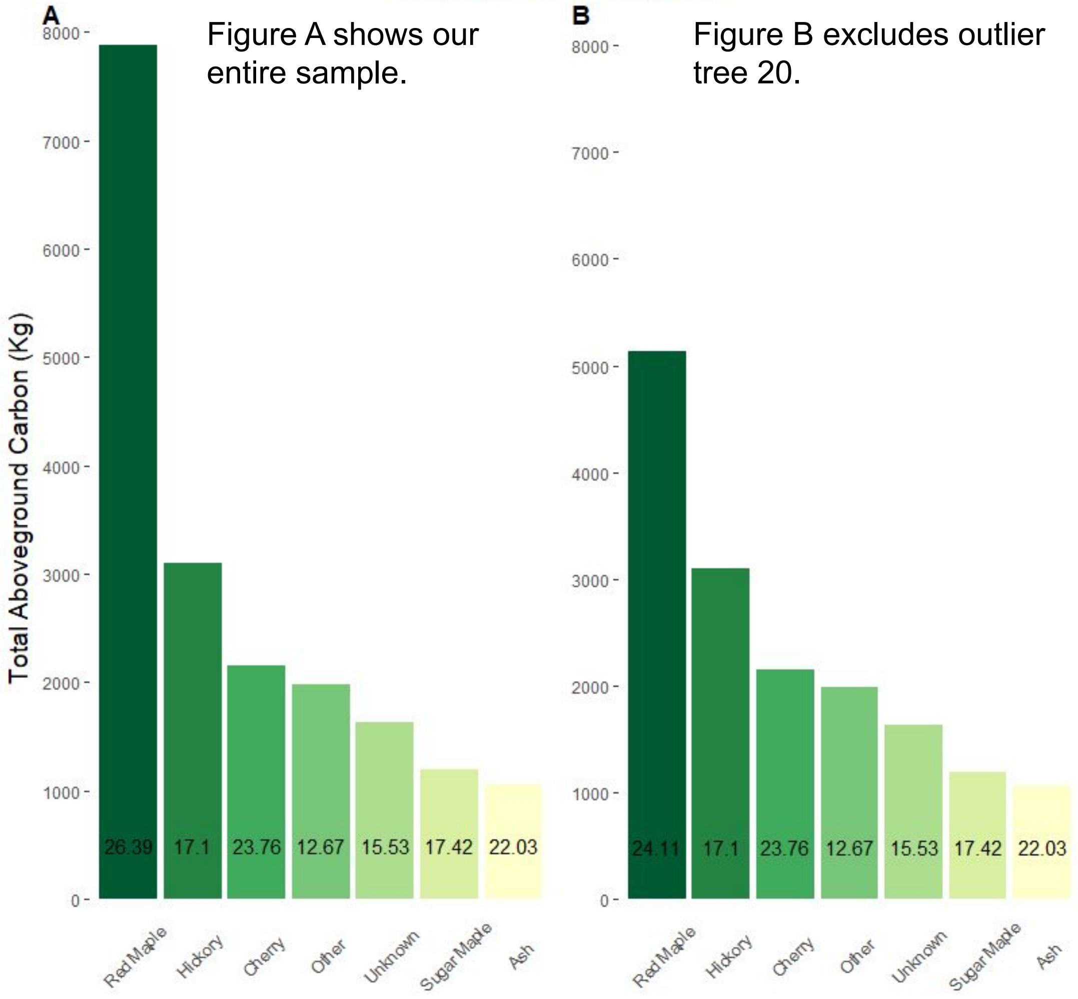
Our plots vary greatly in their total and mean above ground carbon.

Total Carbon per Species

The numbers are average DBH of that species.

Red maple contained by far the most carbon, even excluding tree 20.

Cherry was a large component of the carbon, almost rivaling Hickory even with half as many trees.

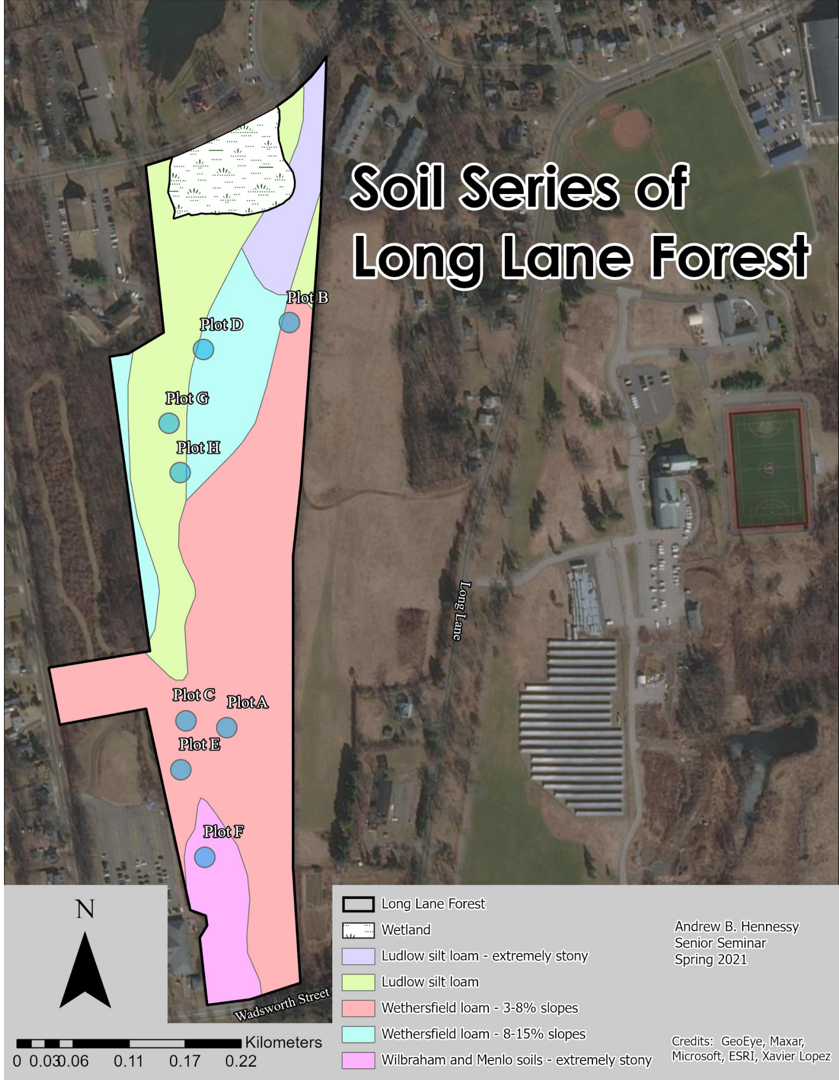


Soil Carbon Estimates

Table 3: Soil carbon measurements from forest plots

Plot ID	Volume of soil (cm³)	Mass of soil (g)	Soil Bulk Density (g/cm³)	Soil Carbon wt. %	Total Soil Carbon per Plot (kg)
A	646.99	548.70	0.83513213	4.629	2729
B	618.36	551.92	0.87900297	5.33	3307
C	562.82	362.74	0.62961311	6.089	2706
D	687.067	685.68	0.98578549	4.073	2834
E	572.56	451.36	0.77368951	5.406	2953
F	649.85	676.63	1.02831388	4.497	3264
G	655.58	543.84	0.8167782	3.271	1886
H	701.38	705.19	0.993484	2.697	1891

Note: Soil volumes were calculated based on the auger radius and length, but may have been an underestimation of total soil volume.



Total Sampled Carbon

Per plot sums of our two measured carbon pools

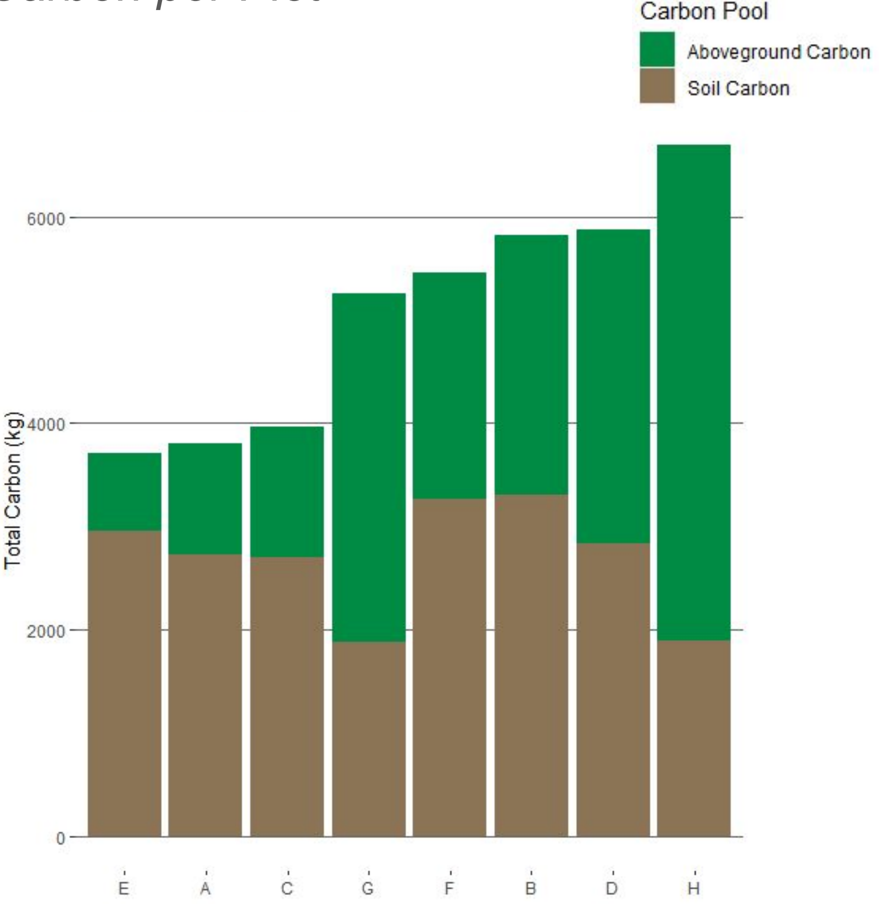
Plot	Mean Carbon per Tree (kg)	Sum Aboveground Carbon (kg)	Soil Carbon (kg)	Total Plot Carbon (kg)
A	57	1,074	2,729	3,802
B	110	2,519	3,307	5,825
C	126	1,257	2,706	3,973
D	69	3,037	2,834	6,117
E	94	752	2,952	3,715
F	91	2,186	3,264	5,482
G	178	3,375	1,885	5,260
H	229	4,802	1,891	6,727
Total	113	19,000	21,568	40,901

Total Carbon

Carbon from our sampled pools extrapolated to the whole forest

Total Sampled Carbon (kg)	Total Forest Carbon (kg)	Carbon per Hectare (kg)
40,901	1,987,826	162,718

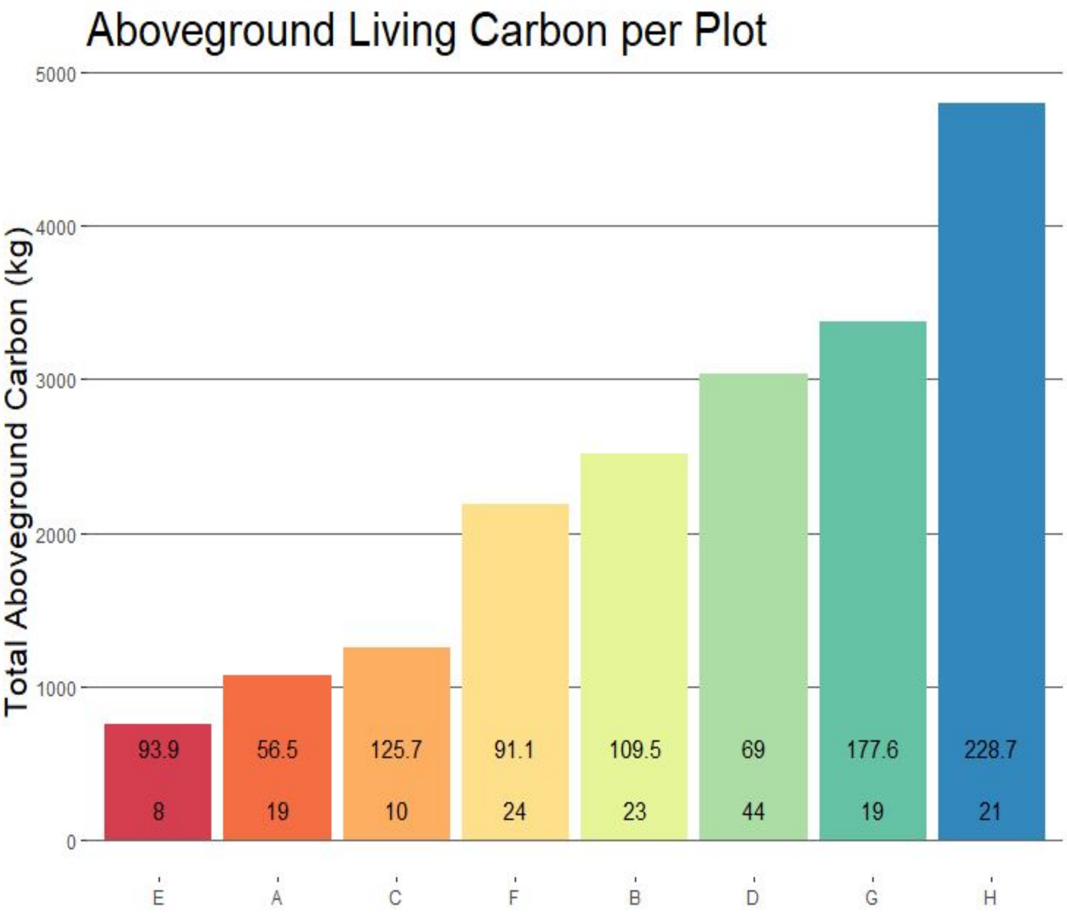
Total Carbon per Plot



Influences on Plot Carbon Storage

1. Quantity of trees

2. Average DBH (including outliers)



The bar numbers are tree count (bottom) and mean carbon per tree (top)

Successional Stage

Young forests have the potential to accumulate more carbon

Increased presence of red maples in NE adds potential for carbon storage

Aerial photos of the Long Lane Forest area from 1934 to 2020. The 2020 photo was taken with a drone in November

Potential for Emissions Offset

2019 travel emissions: 1.65×10^6 kg C
Long Lane Forest: 1.98×10^6 kg C

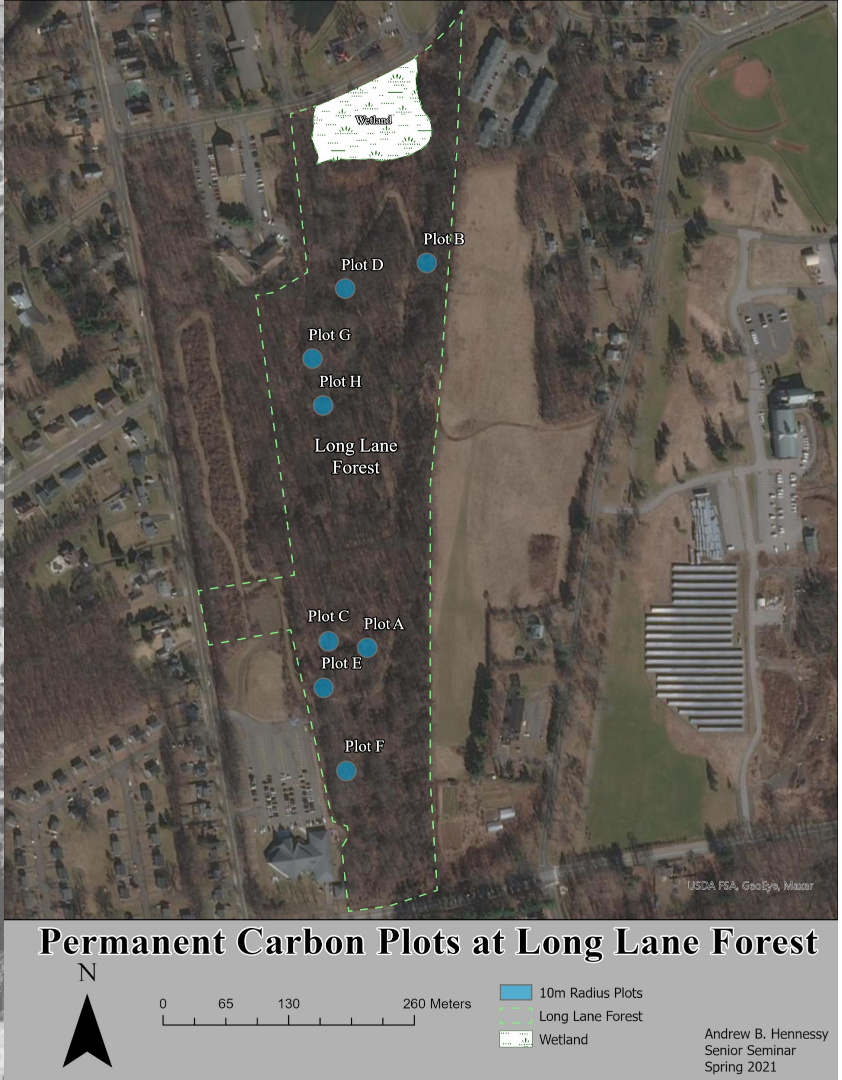
- ➔ LLF would have to sequester 10^6 kg C in a *single year* to completely offset travel emissions
- ➔ Reduction of travel down to 1/10th of the current rate would increase the forests likelihood of sequestering a comparable amount of carbon
- ➔ Convert undeveloped land to forests!

Conclusions

- Field work
  - Established 8 plots
  - Tree and soil sampling
- Laboratory work
  - Tree carbon analysis
  - Soil analyses
- Forest analysis
  - Understory
- Carbon sink potential
  1. More studies
  2. Re- and afforestation
  3. ↓ campus emissions

Class photo taken with drone [Missing Phia, Yuke, Kush]
(image by Joel Labella)


WEST


Wetland
Plot B
Plot D
Plot G
Plot H
Long Lane Forest
Plot C
Plot A
Plot E
Plot F
USDA FSA, GeoEye, Maxar
Permanent Carbon Plots at Long Lane Forest
N
0
65
130
260 Meters
10m Radius Plots
Long Lane Forest
Wetland
Andrew B. Hennessy
Senior Seminar
Spring 2021

Aerial photos

Aerial photos of the Long Lane Forest area from 1934 to 2020. The 2020 photo was taken with a drone in November

1. Plot setup
2. Lab components
3. Equations
4. Comparisons to other research forests
5. Comparisons to Northeast
6. Wesleyan’s goals
7. Future directions for forest
8. Forest history

Potential Questions / Answers