Title
Abbott Park Forest Carbon Assessment

Authors
Cherkis, Allen., Minor, Jesse., Fischer, Eve

Abstract
Forests are globally important carbon sinks. Using University of Maine at Farmington's Abbott Park, our research asks: 1) How much carbon is stored in Abbott Park? 2) How does carbon storage vary by species? 3) Do patterns of forest regeneration suggest that the future forest will differ in carbon storage potential?

Introduction
Data were collected in 150 m^2 belt transects in which diameter breast height (DBH)of all trees ≥ 5 cm were recorded by species. Seedlings and saplings were tallied by species. Allometric equations were used to calculate standing biomass and total carbon. Total carbon storage in Abbott Park was found to be approximately 508,221 kg (560 metric tons).

As of 2018, the total greenhouse gas emissions in the atmosphere were equivalent to 6,677 metric tons of CO_2 (United States Environmental Protection Agency, 2020). Because trees and other vegetation naturally take in carbon from the atmosphere, a forest can be thought of as a natural carbon sink. Carbon sinks offset carbon emissions to a certain degree and therefore are important to understand as we attempt to mitigate anthropogenic climate change. One example of such a carbon sink is the University of Maine at Farmington's Abbott Park.

This research aims to not only calculate overall tree biomass in the forested area of Abbott Park, but also conduct analyses using allometric modelling to calculate how much standing carbon is represented among various species groups and biomass components (bole, foliage, and coarse roots). Carbon sequestration characteristics vary amongst different tree species, meaning that total forest carbon sequestration will depend upon the number, size, and species composition of trees.

We will also consider the understory composition of forested Abbott Park. By collecting data of current tree regeneration patterns, we hope to predict how Abbott Park's mature tree overstory may look in the future and if such forest succession predictions imply a differing capacity for carbon storage going forward.

Methods & Materials
- Data were collected in 14 150 m^2 belt transects (5 m x 30 m)
- All trees with diameter breast height (DBH) ≥ 5 cm were measured and recorded by species
- All seedlings (trees < 1.37 m in height) and saplings (trees > 1.37 m but < 5 cm DBH) were tallied by species

- Allometric equations developed by the US Forest Service for North American tree species (Jenkins et al. 2003) were used to calculate biomass and carbon of whole trees and components (coarse roots, boles, and foliage)
- Wooded and non-wooded areas of Abbott Park were mapped using Garmin GPS units to allow for extrapolation of total forest carbon stores
- Data were organized, analyzed and visualized using Microsoft Excel

Results

Overall amount of CO_2 sequestered from trees in Abbott Park was found to be 508,221 kg (560 metric tons), according to allometric modeling. The hard maple, beech, hickory and oak group are a majority of Abbott Park's forest at 77% of total composition. The birch/soft maple group were the least present at 1% of total composition.

In our calculation of average carbon storage (kg) per species group (normalized to cm per DBH) the soft maple/birch group was found to store the most at 23.07 kg. The pine group was found to store the least amount of carbon.

Seedling/sapling counts showed mixed hardwoods as the majority understory species group at 70% of the total. The hard maple, beech, hickory and oak group represented 22% of the total. The group with the least amount of abundance was hemlock/fir at 1% of the total.

Analysis of biomass components concluded that total carbon storage in Abbott Park is 76% bole, 21% coarse roots, and 3% foliage. Hardwoods were found to store ~9% more foliar carbon per cm DBH in roots on average than softwoods.

Discussion

After gathering and analyzing forest composition data, understory regeneration patterns suggest noteworthy differences between the current and future Abbott Park. As seen in *Figure 1*, the current overstory in Abbott Park contains 77% hard maple, hickory, and oak, while next largest portion is mixed hardwood with 13%. In contrast to this, the understory regeneration pattern suggests that mixed hardwood will take ~70% of the forest composition in the future while hard maples, beech, hickory and oaks will drop to ~22% (*Figure 3*). The latter sequesters slightly less carbon per cm DBH compared to mixed hardwoods (*Figure 2*), so this could suggest an overall decrease in carbon sequestration. However, mixed hardwoods were also observed as the tallest growing of all species groups and on average were about 5 meters taller than the hard maple, beech, hickory and oak group. This added biomass may be enough to increase total sequestered carbon in Abbott Park's future.

Conclusions

- Soft maples/birch trees were found to sequester the most carbon per cm DBH on average
- The hard maple, hickory, beech and oak group sequesters the most total carbon due to greater dominance in forest composition

- Regeneration patterns suggest that mixed hardwood will likely become the dominant overstory species group by a wide margin
- Despite sequestering slightly less carbon per cm of DBH than the current dominant species group, mixed hardwoods are approximately 5 m taller on average. This implies that future carbon storage could increase on account of greater overall biomass
- This research will ideally contribute to an ongoing carbon assessment of other UMF-owned carbon sinks such as Beaver Brook and the Johnson Heights peat bog, and its surrounding hemlock forest

Acknowledgements

We thank the Fall 2020 EPP/GEO 207 *Environmental Field Methods* class at the University of Maine at Farmington for conducting data collection. We also to thank the UMF staff who are responsible for managing Abbott Park and for allowing us to conduct research there.

Literature Cited

Sources of greenhouse gas emissions. (2020, December 04). Retrieved March 29, 2021, from https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Jenkins, J.C., Chojnacky, D.C., Heath, L.S. and Birdsey, R.A., 2003. National-scale biomass estimators for United States tree species. Forest science, 49(1), pp.12-35.