BIOMASS:

CARBON STORAGE IN NEW YORK AND NEW JERSEY

Gabriel Rosenstein
Benjamin Yang
Amani Rodriguez
Alice Yan


01

THE PROBLEM

And the forest biomass solution

02

GROUND TRUTHING

To supplement remote sensing

03

METHODS

And their limitations

04

OVERALL TRENDS

05

CASE STUDIES

Succession
Fire
Disease

05

THE COMPLETE PICTURE

THE PROBLEM

AMBITIOUS EMISSION TARGETS

New York: 85% of its 1990 state wide GHG emissions by 2050.
The *Climate Leadership and Community Protection Act 2019*

New Jersey: 80% of its 2006 state wide GHG emissions by 2050.
Global Warming Response Act

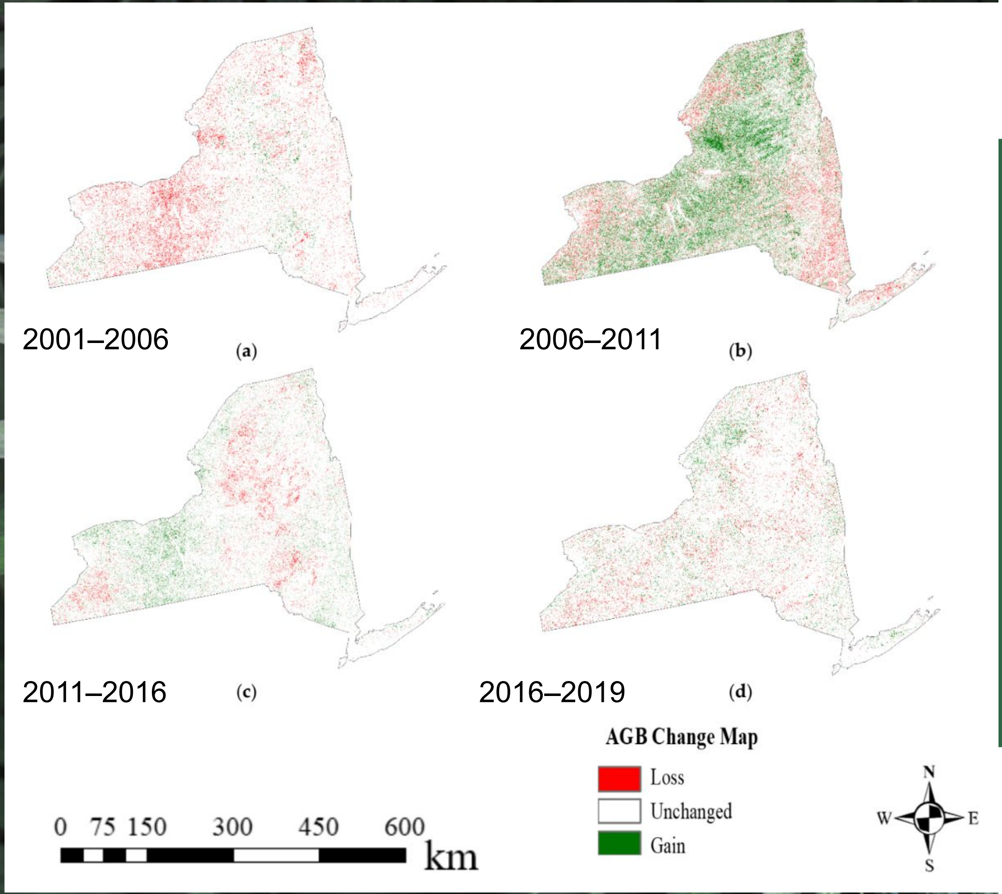
BIOMASS SOLUTION

CARBON SEQUESTRATION

Forests will play a crucial role

New York:
Forest cover: 61%
Biomass: 3.2 billion tons
Carbon: 1.6 billion tons

New Jersey:
Forest cover: 45%
Biomass: 118.8 million tons
Carbon: 59.4 million tons



Tamiminia et al 2022

REMOTE SENSING

LiDAR suggests a decline in aboveground New York forest biomass in recent years

GROUND TRUTHING

What are site-level carbon sequestration trends and do they align with landscape-level trends?

METHODS: (1) SELECTING DATA

SELECT SITES

- 4+ years of stand-level fidelity or
- 2+ years of plot-level fidelity

POOL DATA

- 2006 removed due to sampling of different size classes.
- Included live and dead trees.

CLEANUP

- No shrubs
- Each measured stem = new tree measurement
- Standardization of genus names

METHODS: (2) ALLOMETRIC FORMULAS

LITERATURE SEARCH

Comprehensive and recent collection of allometric equations

CHOJNACKY (2014)

Genus-level equations
Family-level equations

JENKINS (2003)

Mixed hardwood equation

METHODS: (3) RELATIVE BIOMASS CALCULATION

GENERATING BIOMASS EQUATIONS

$\text{Exp}(\beta_0 + \beta_1 \ln(\text{dbh}))$
Absolute biomass in kg

CALCULATING PLOT SIZE

Trees with DBH < 10 cm: r=5 m
Several 2014 plots: r=20 m
All others: r=10
Area in hectares = $\pi r^2 x\ 10^{-4}$

RELATIVE BIOMASS

Biomass in kg x 10^{-3} / plot area = Mg of biomass per hectare

METHODS: (4) ANALYZING DATA IN PYTHON

SELECT BIOMASS (MG HA^{-1})

Column in CSV file with value for each tree in each forest plot.

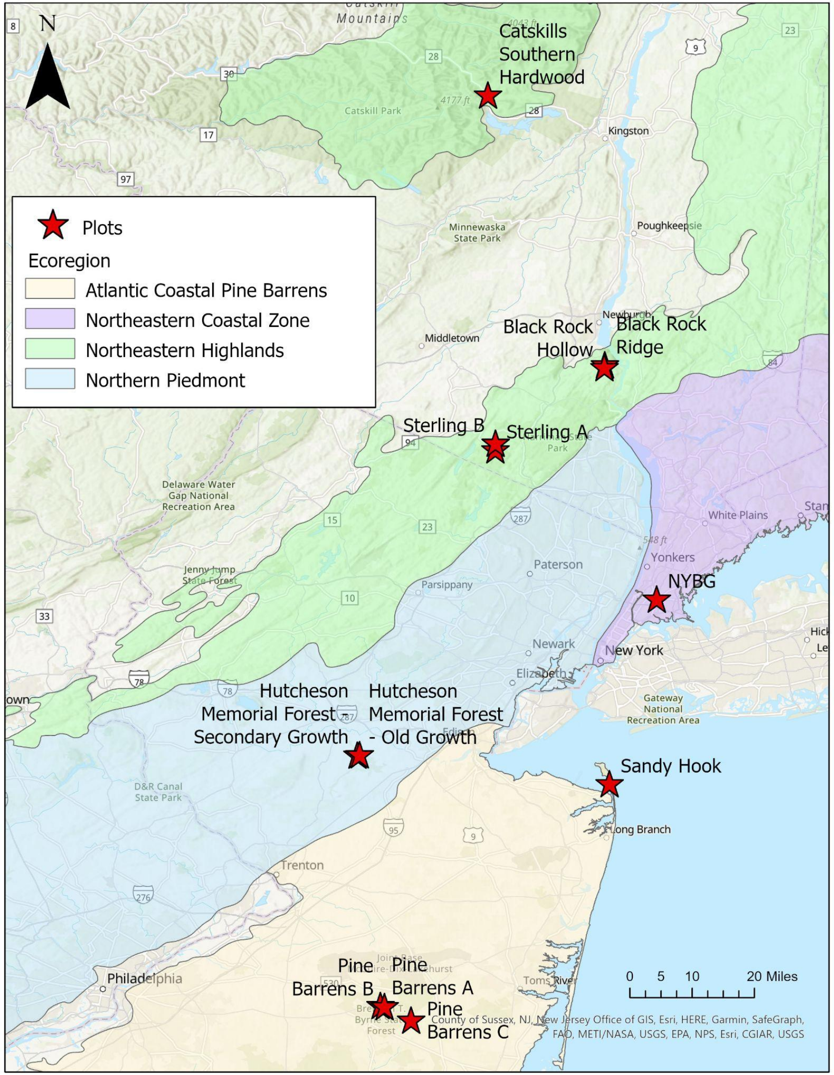
COMPUTE STATISTICS

Combine (sum) by year, group #, and genus. Find mean, standard error, and linear regression line.

CREATE GRAPHS

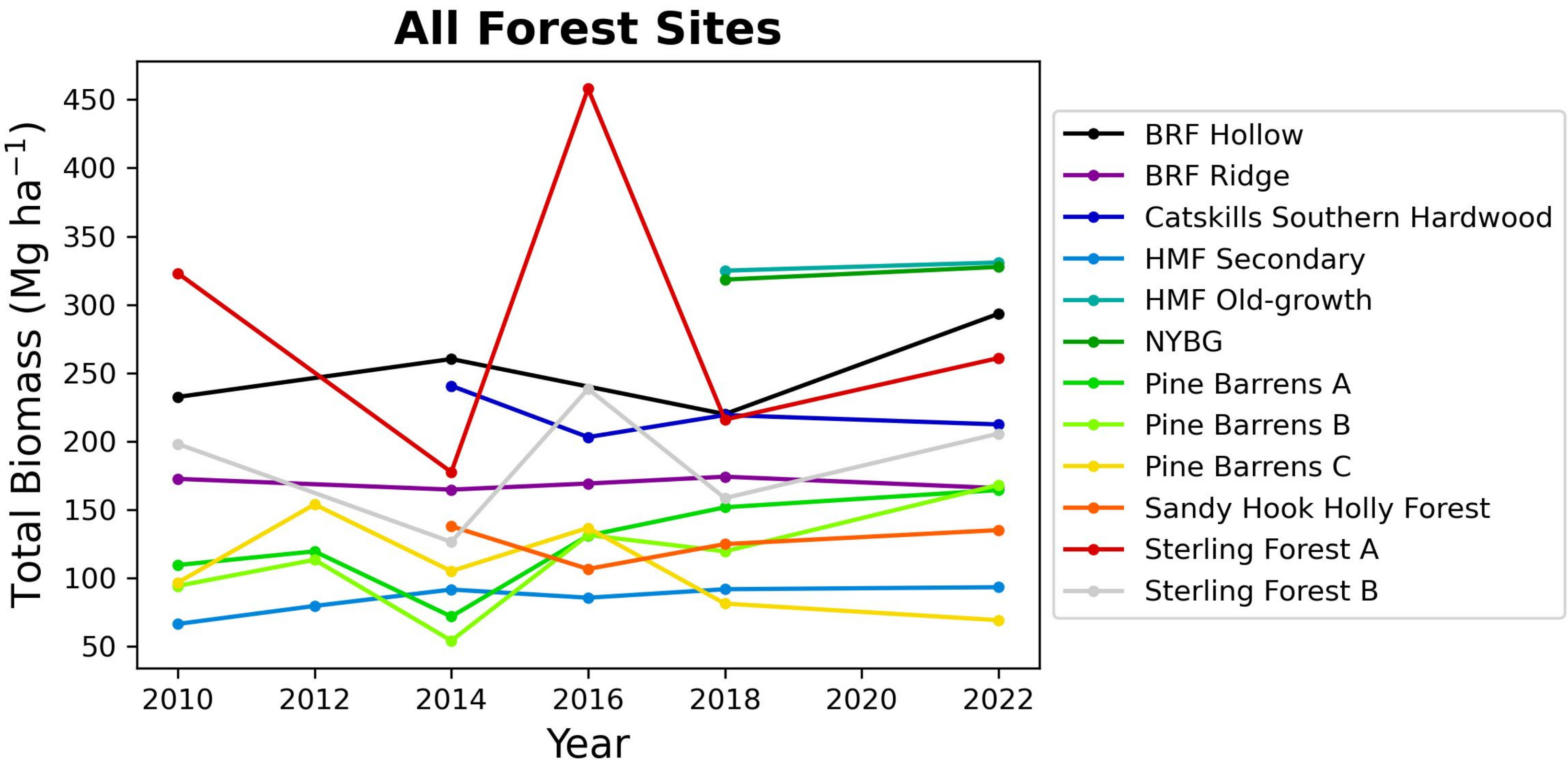
Total biomass vs. year for all trees and by genus (top 5) at each site. Compare all sites together: biomass vs. year and rate of change.

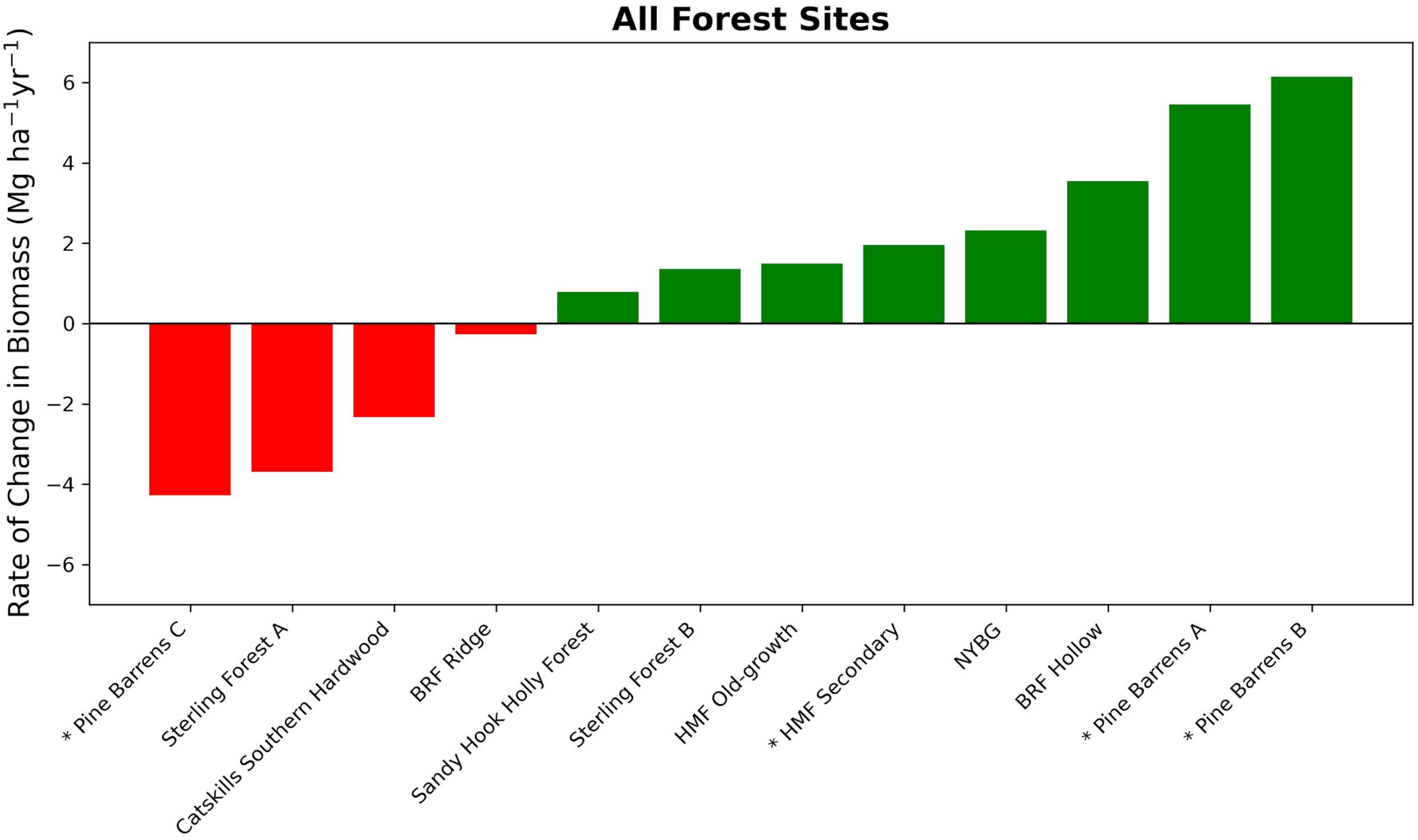
RESULTS



Ecoregions derived from United States Environmental Protection Agency, 2022

RESULTS


All Forest Sites
Total Biomass (Mg ha^{-1})
Year
450
400
350
300
250
200
150
100
50
2010
2012
2014
2016
2018
2020
2022
BRF Hollow
BRF Ridge
Catskills Southern Hardwood
HMF Secondary
HMF Old-growth
NYBG
Pine Barrens A
Pine Barrens B
Pine Barrens C
Sandy Hook Holly Forest
Sterling Forest A
Sterling Forest B



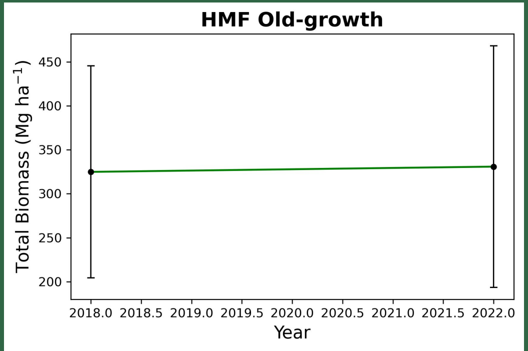
All Forest Sites
Rate of Change in Biomass (Mg ha^{-1}yr^{-1})
6
4
2
0
−2
−4
−6
* Pine Barrens C
Sterling Forest A
Catskills Southern Hardwood
BRF Ridge
Sandy Hook Holly Forest
Sterling Forest B
HMF Old-growth
* HMF Secondary
NYBG
BRF Hollow
* Pine Barrens A
* Pine Barrens B

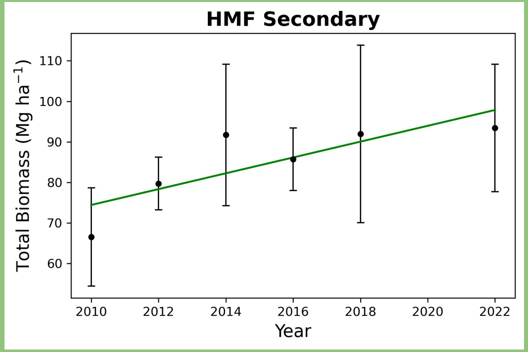
CASE STUDY 1: SUCCESSION

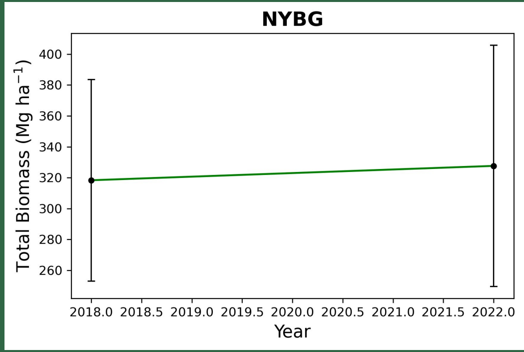
- Perception that younger forests sequester more carbon due to quick growth and higher density. Heterotrophic respiration from disturbance might actually result in CO_2 release larger than NPP.
- For most species, mass growth rate increases continuously with tree size, and large trees actively fix large amounts of carbon. (Stephenson et al. 2014)
- 98.9% of North American tree species have an increasing mass growth rate in the largest trees (>100cm DBH)

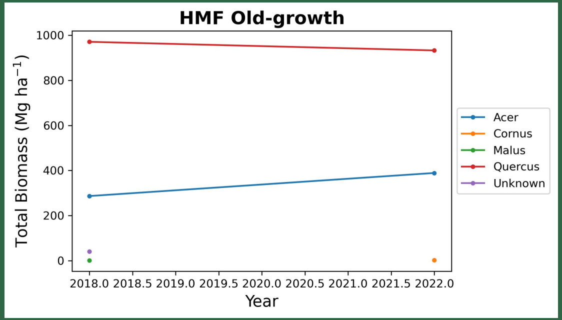
- Hutcheson Memorial Forest, two sites: 60 year old secondary successional forest, old growth forest >300 years old
- New York Botanic Garden: Old growth Thain Forest is the oldest uncut upland forest in New York City.

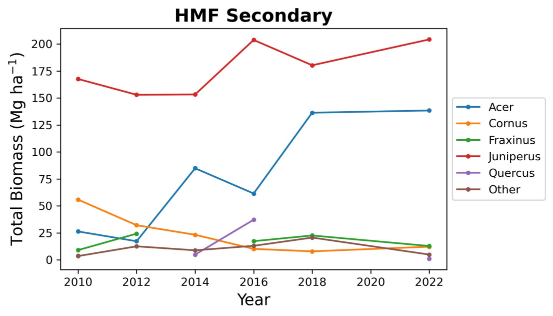
HUTCHESON MEMORIAL FOREST AND NYBG

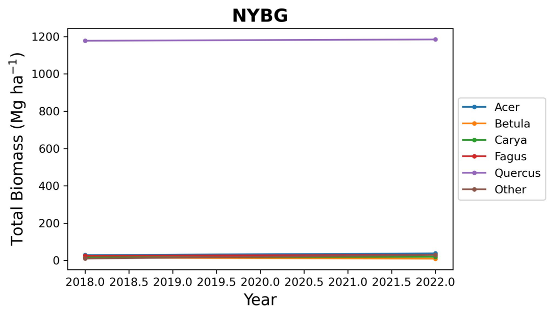




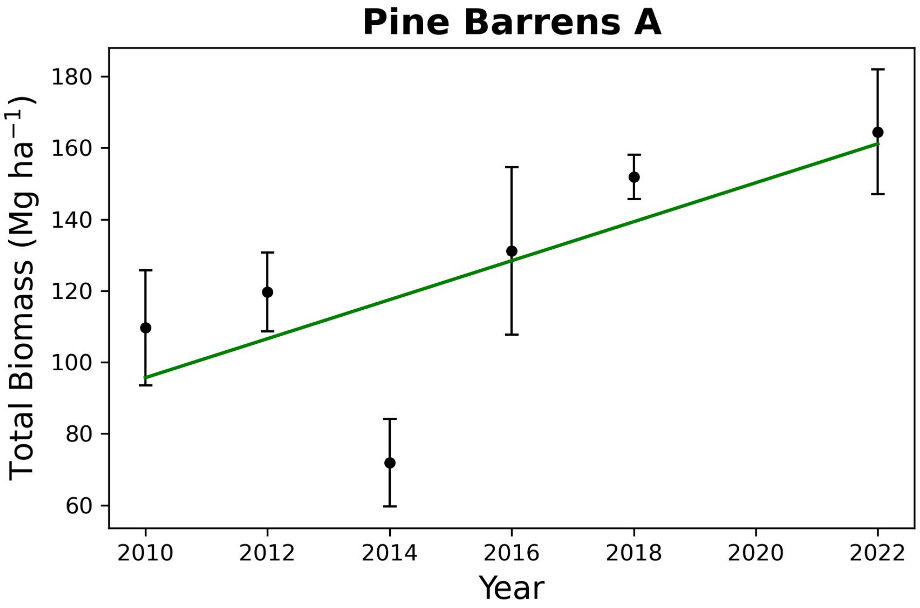


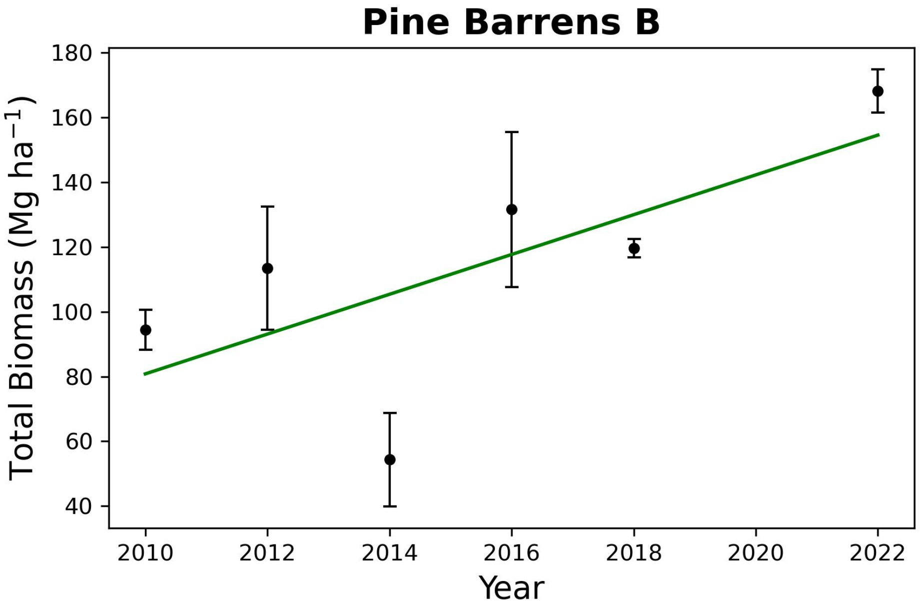




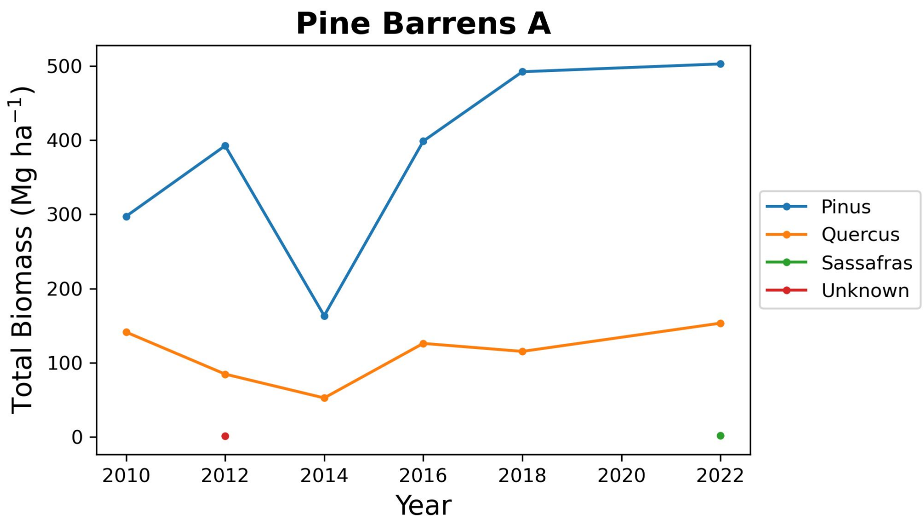


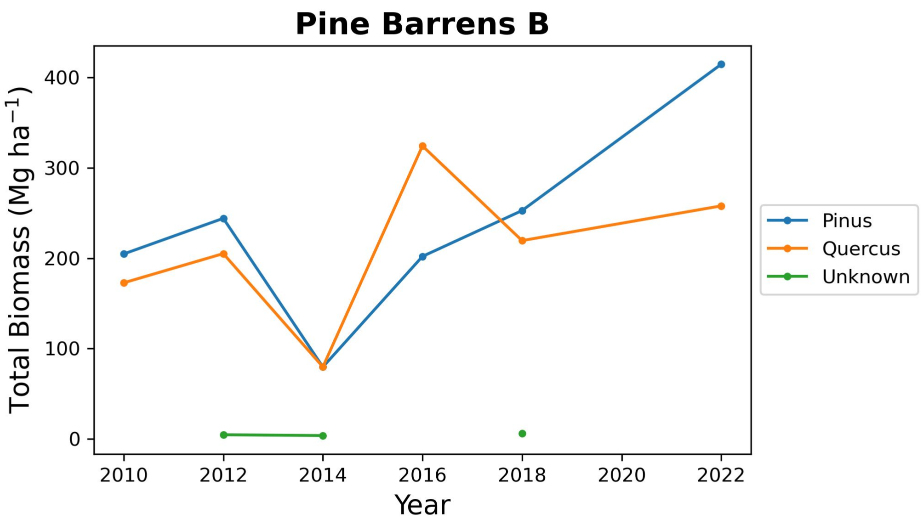
CASE STUDY 2: FIRE



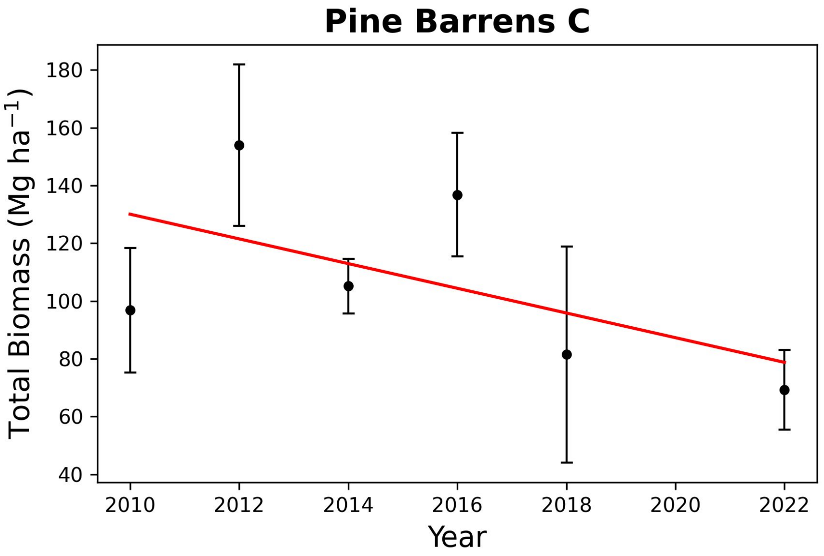


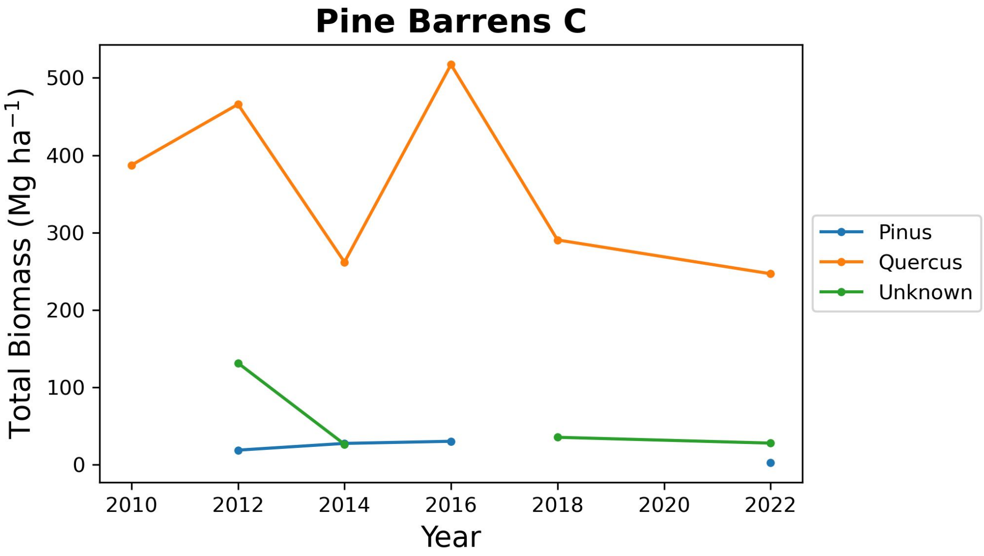
NJ PINE BARRENS UPLAND FORESTS





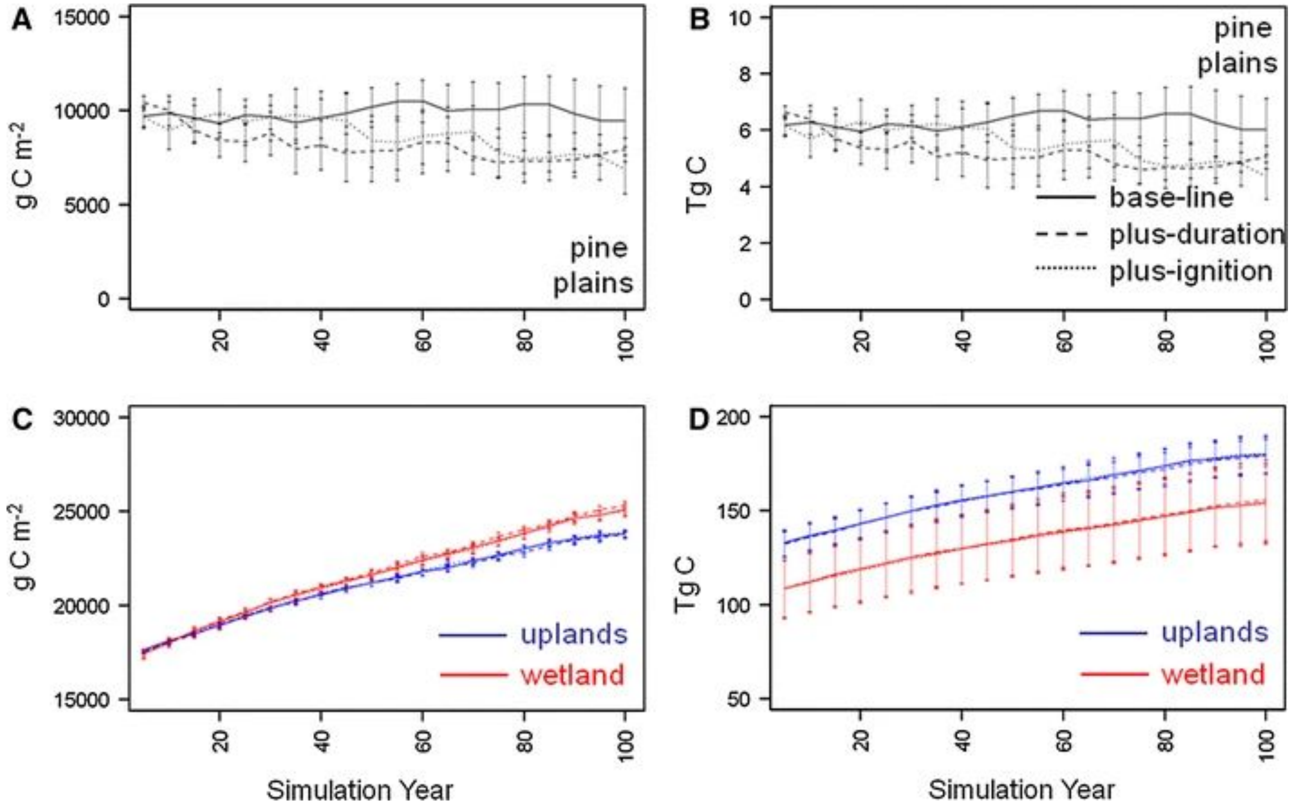
NJ PINE BARRENS UPLAND FORESTS



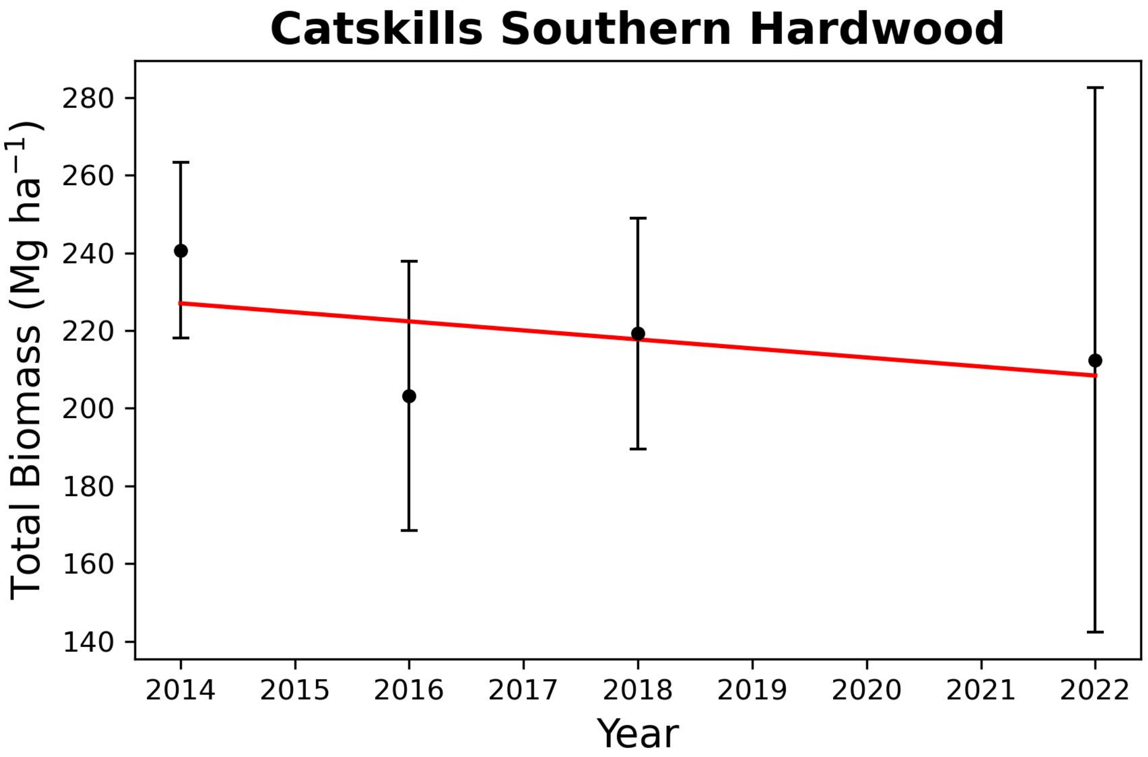


DIFFERENT FIRE MANAGEMENT SCENARIOS

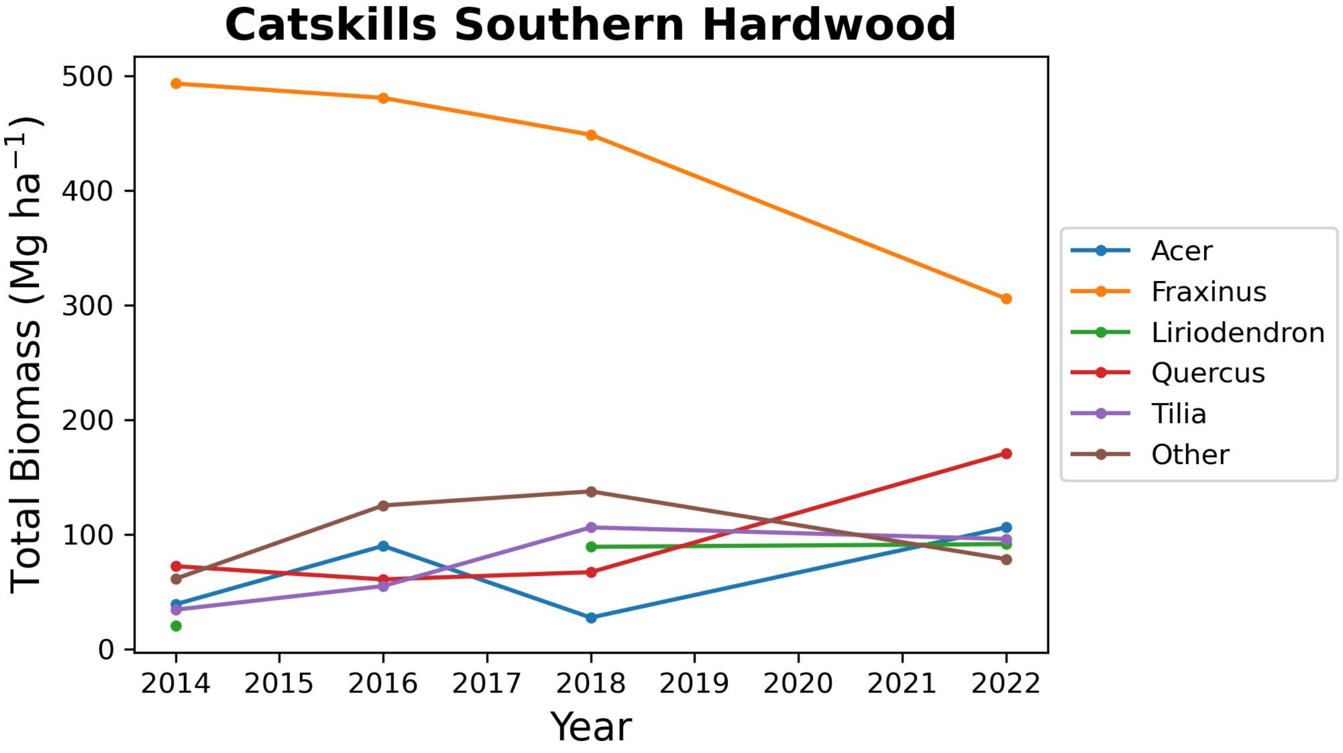
Reference: Scheller et al. (2011)



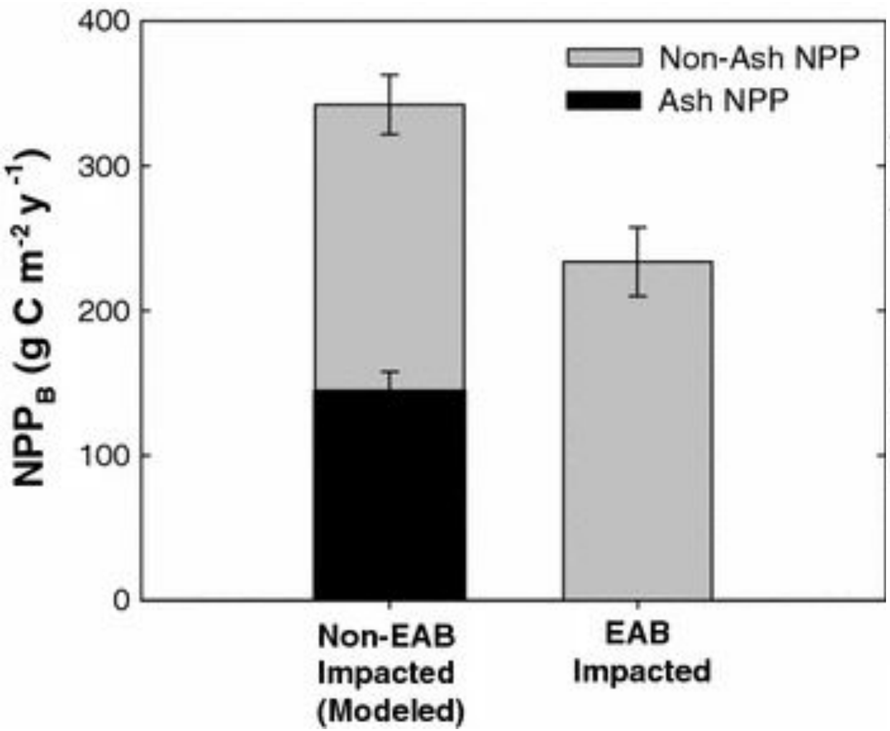
CASE STUDY 3: DISEASE

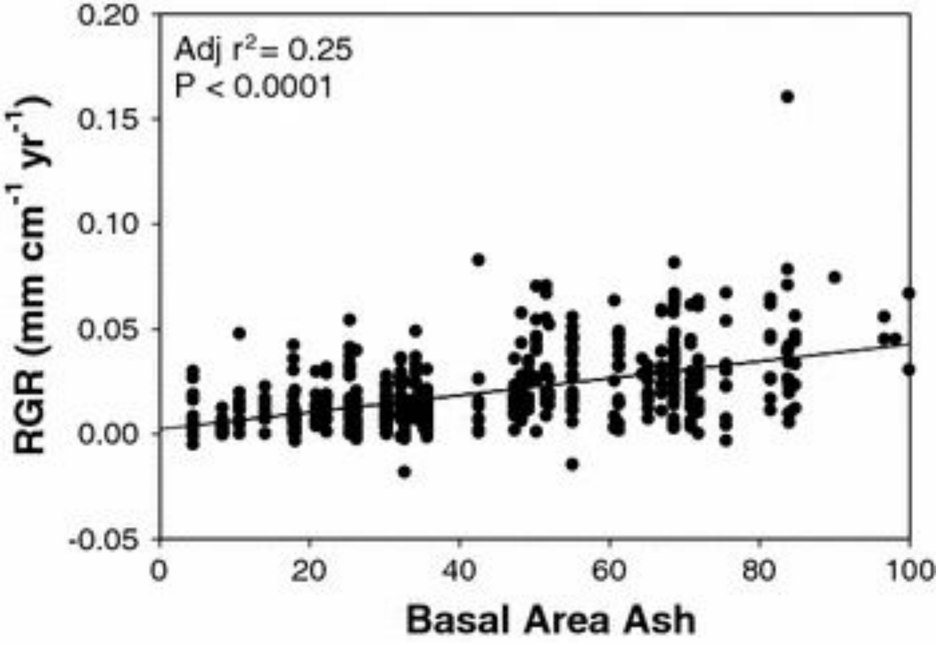


CATSKILLS SOUTHERN HARDWOOD BY GENUS



EFFECTS OF EMERALD ASH BORER (EAB) IN NW OHIO





Reference: Flower et al, 2013.

STUDY LIMITATIONS

SITE INCONSISTENCY

Only some plots had a permanent rebar center; the majority were moved around every year.

LIMITED DATA

We eliminated data that was inconsistent or insufficient - reducing our overall pool of data

QUESTIONABLE TRENDS

2016 Sterling Forest Location A shows huge unexplained peak in biomass, 2014 different methods

UNIDENTIFIED SPECIES

Many species were unidentified or “best guesses”

FINAL THOUGHTS

STATEWIDE TRENDS

Satellite data shows an overall decline in aboveground biomass of forests in recent years.

OUR RESULTS

-HMF and NYBG show slight increases in biomass
-Pine Barrens results vary due to fire history and study limitations
-Catskills show decline due to emerald ash borer

CONCLUSION

Statewide trends mask complex ecosystem dynamics that vary dramatically between forests.

REFERENCES

Chojnacky, David C., Heath, Linda S., & Jennifer C. Jenkins. 2014. "Updated generalized biomass equations for North American tree species." *Forestry*. 87: 129-151.

Flower, Charles E., Knight, Kathleen S., & Gonzalez-Meler, Miquel A. 2013. "Impacts of the emerald ash borer (Agrilus planipennis Fairmaire) induced ash (Fraxinus spp.) mortality on forest carbon cycling and successional dynamics in the eastern United States." *Biological Invasions*. 15: 931–944. https://doi.org/10.1007/s10530-012-0341-7

Jenkins, J., Chojnacky, D., Heath, L., & Birdsey, R. 2003. "National-scale biomass estimators for United States tree species." *Forest Science*. 49(1): 12-35.

Scheller, R.M., Van Tuyl, S., Clark, K.L. et al. Carbon Sequestration in the New Jersey Pine Barrens Under Different Scenarios of Fire Management. Ecosystems 14, 987–1004 (2011). https://doi.org/10.1007/s10021-011-9462-6

Stephenson, N.L., et al. 2000. "Rate of tree carbon accumulation increases continuously with tree size". *Nature*. 507. 10.1038/nature12914.

Tamiminia, Haifa, Salehi, Bahram, Masoud, Mahdianpari, Beier, Colin M. & Johnson, Lucas. "Mapping Two Decades of New York State Forest Aboveground Biomass Change Using Remote Sensing." *Remote Sensing*. 14: 4097.

United States Environmental Protection Agency. 2022. "Level III and IV Ecoregions of the Continental United States." https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states