Proposal: Variation in Forest Carbon Stocks by Forest Ownership and Protected Area Type in the Conterminous United States
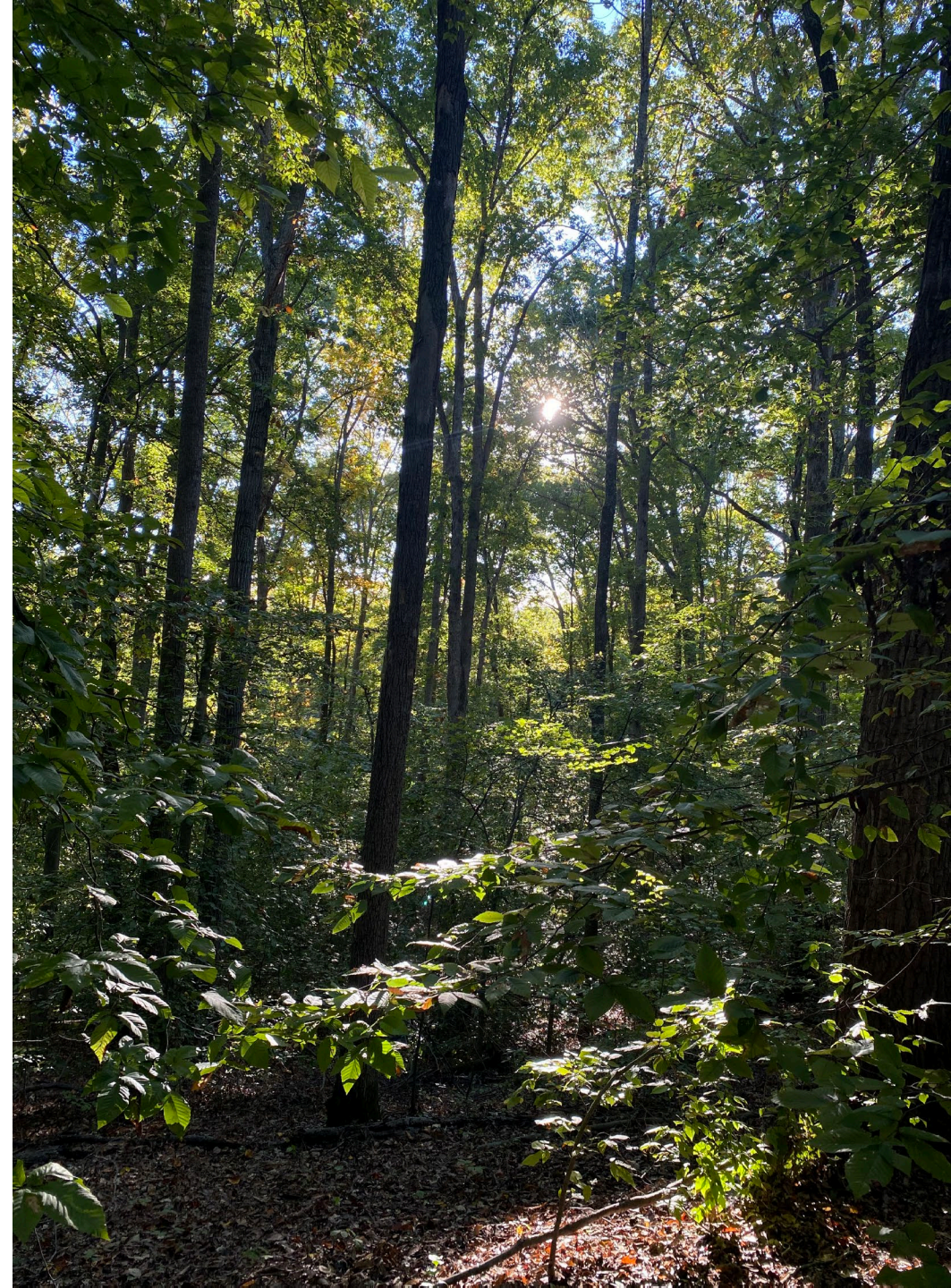
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10/23/2023

GEOG 596A

Why look at forests?

- Crucial in the fight against climate change

- The most important land type for carbon storage (sequestration):

- *Forests offset more carbon dioxide emissions than any other type of land, like grasslands or agriculture*

Forests store carbon

- Forests sequester carbon by capturing CO_2 from the atmosphere and transforming it into biomass via photosynthesis
- Carbon is stored in carbon pools:
  - Aboveground living biomass (e.g., leaves, limbs, trunks)
  - Belowground living biomass (e.g., roots)
  - Dead wood
 - Litter on the forest floor
  - Soils
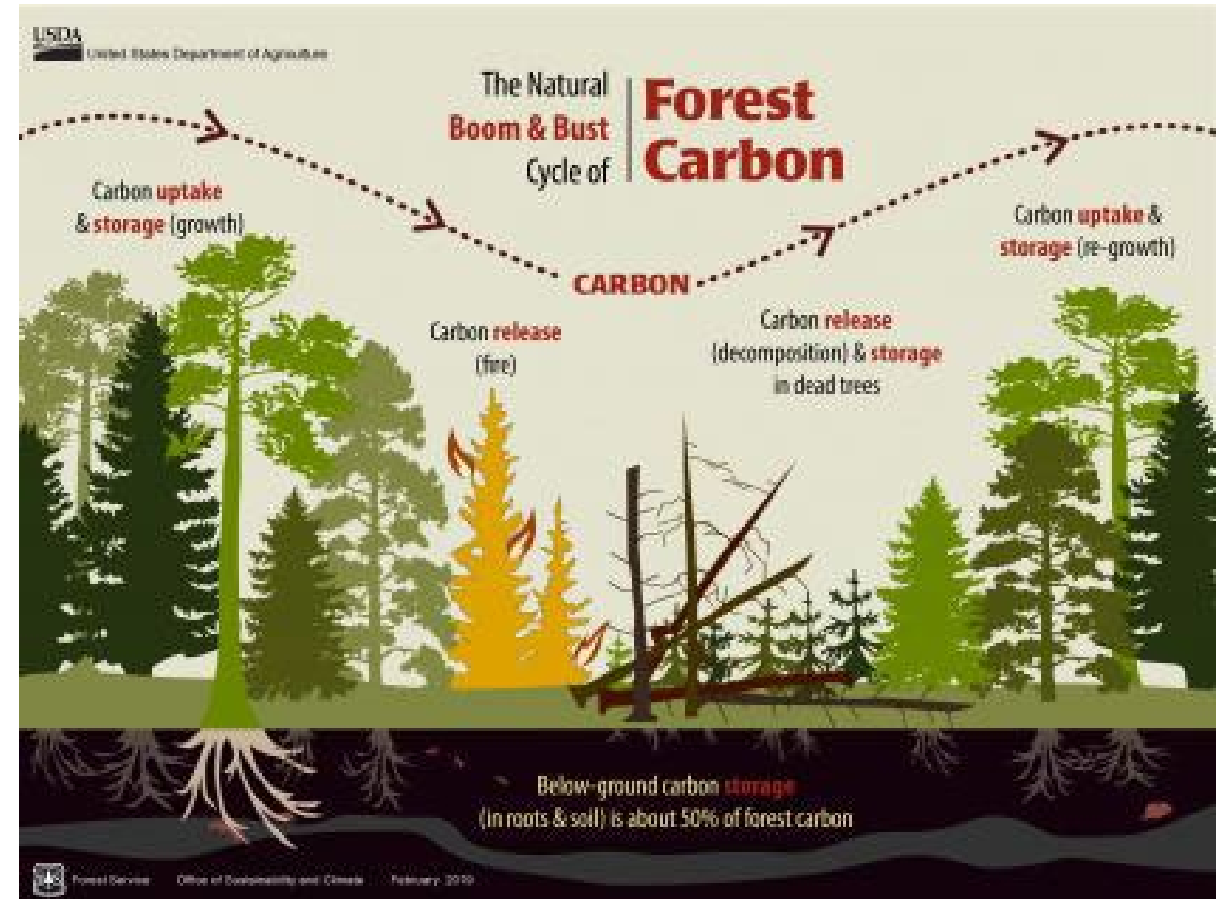
How is carbon released in the atmosphere?

- Both natural and human-caused disturbances (fire, decomposition, development)

- Logging can release carbon into the atmosphere, but sustainable practices should keep forests as forests as trees are replaced in the area for future harvest

- Carbon is stored in wood products like furniture, housing materials, flooring

Forests in the United States

- Forests cover approximately 33% of land

- Almost 766 million acres of trees storing over 866 million metric tons of carbon per year

- America's forests offset about 16% of the nation's domestic carbon emissions per year

- Different types of forests across the US

500 km

Total Tree Canopy Cover (deciduous and evergreen, %)

0   20   40   60   80   100
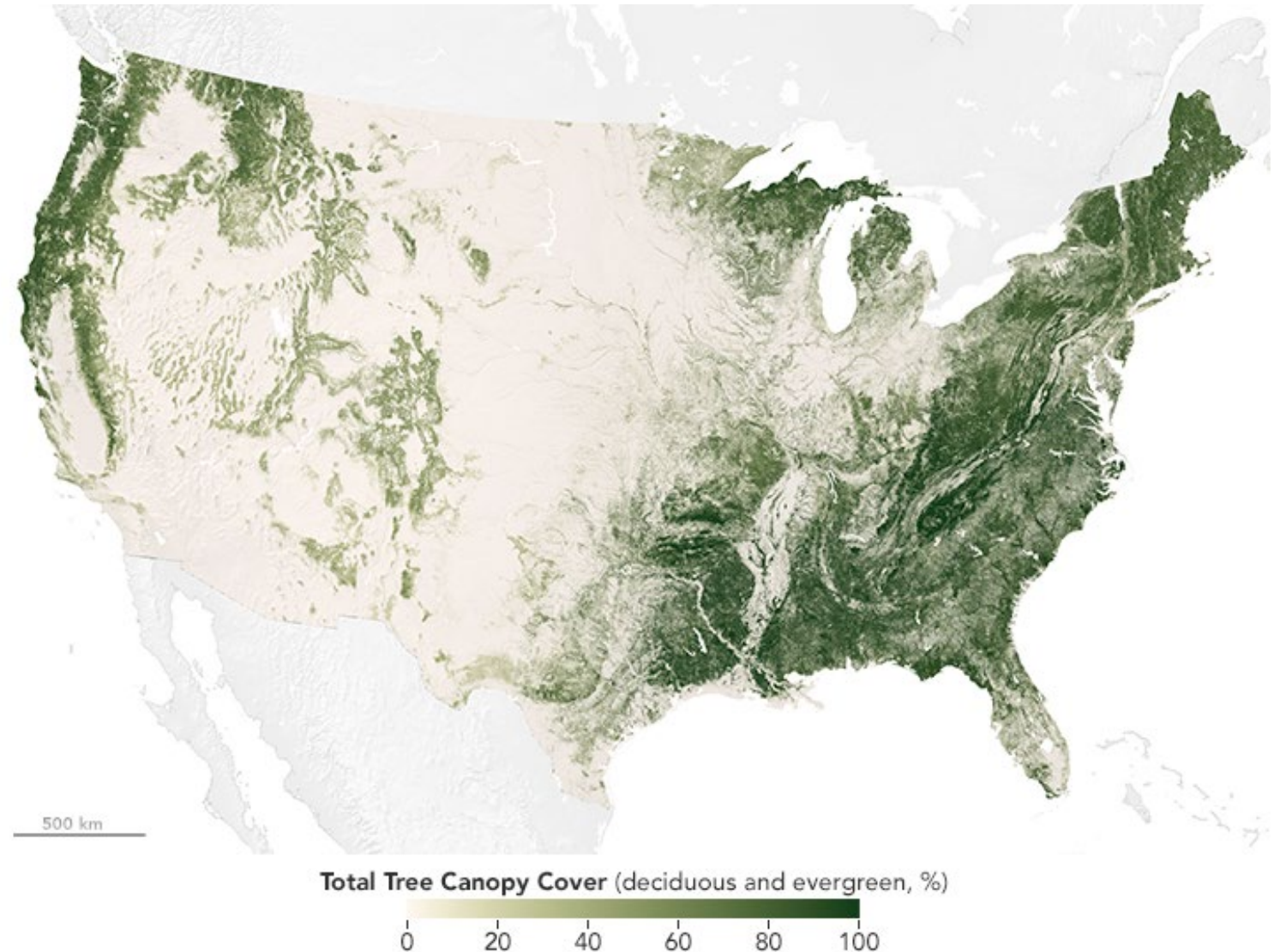
Wide variety of forest ownership

- Forest ownership is spread across several entities, both public and private

- The U.S. federal government owns 238 million acres (31%) of the nation's forested land

- Remaining 69% of U.S. forests (527 million acres) are nonfederal and predominately privately owned

Study on forest carbon in PAs in Uganda

- Gizachew et al. (2018) measured forest carbon gain and loss for 713 protected areas (PAs) in Uganda over a twelve-year period from 2000-2012

- They found that carbon gain or loss varied significantly between the different management categories of the PAs

- Also found that forest degradation and development threatened the carbon sink potential of the PAs

- These findings may inform policy as they suggest an urgent need to look into management techniques of PAs

Goals and objectives

- I want to examine forest carbon stocks in different types of PAs in the United States

- I aim to examine the distribution of forest carbon across ownership types in the conterminous United States, based on Sass et al. dataset

- I also want to visualize how forest carbon levels vary between different types of ownership, both between public and private lands and within the subcategories of those two categories, too

Research questions

- How do levels of forest carbon in publicly-owned forests compared to that of privately-owned forest?

- Which ownership type has the highest amount of forest carbon?

- How do carbon stocks compare between protected area forests, like fee and easement?

- Are there any discernible patterns of level of forest carbon stocks when compared to type of ownership?

The Datasets

- Yu et al. forest carbon data

- Sass et al. forest ownership types

- USGS Protected Areas dataset

2017 Aboveground
Live Biomass (Mg/ha)

High : 6639

Low : 0

km
0   250   500   750   1,000
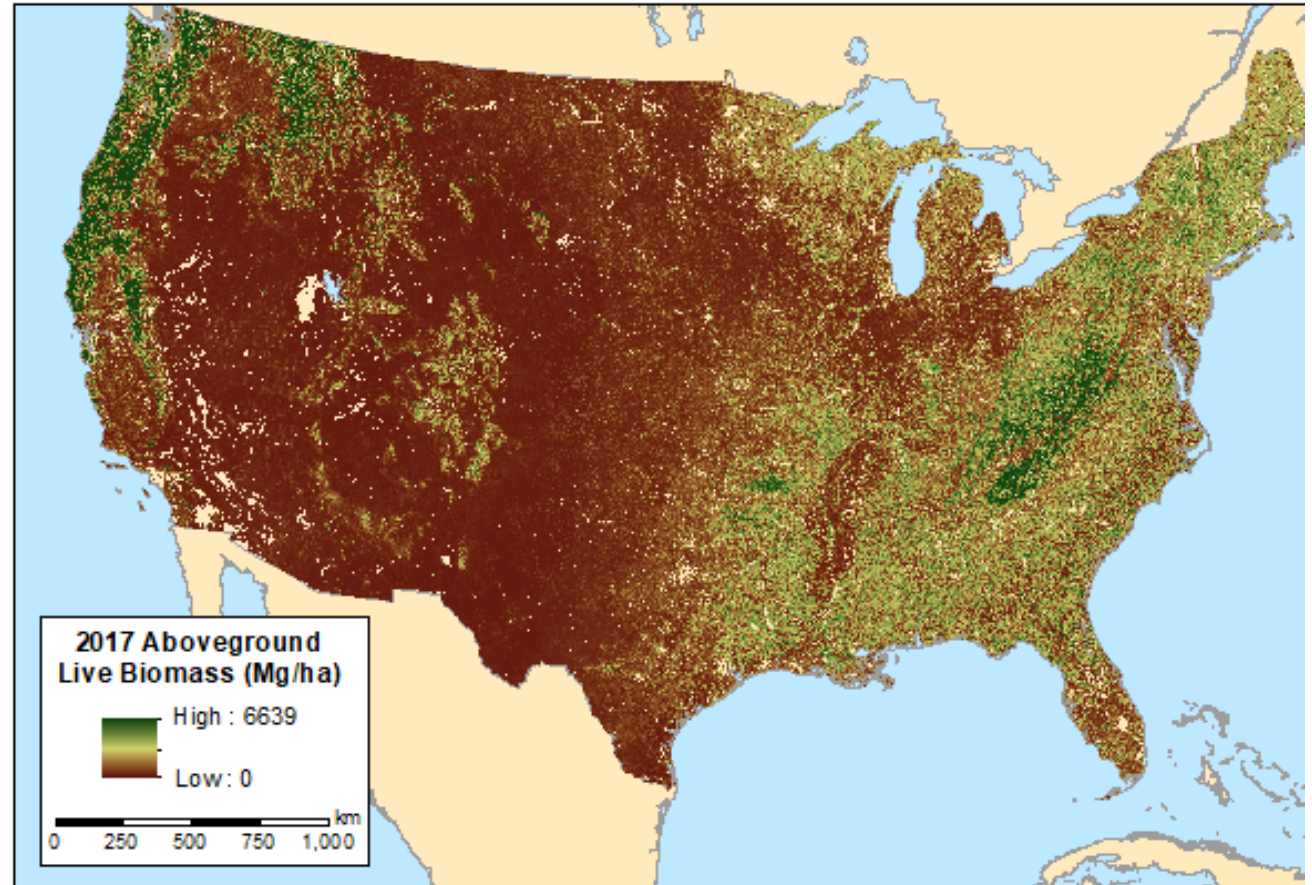
Forest Ownership Dataset (Sass et al.)

Forest Ownership Type	Definition
Family (Private)	Owned by families, individuals, trusts, estates, family partnerships, and other unincorporated groups of individuals that own forest land.
Corporate (Private)	Owned by corporations.
TIMO/REIT (Private)	Owned by Timber Investment Management Organizations or Real Estate Investment Trusts.
Other Private (Private)	Owned by conservation and natural resource organizations and unincorporated partnerships and associations.
Federal (Public)	Owned by the federal government.
State (Public)	Owned by a state government.
Local (Public)	Owned by a local government.
Tribal	Owned by Native American tribes

Protected Areas Database (USGS)

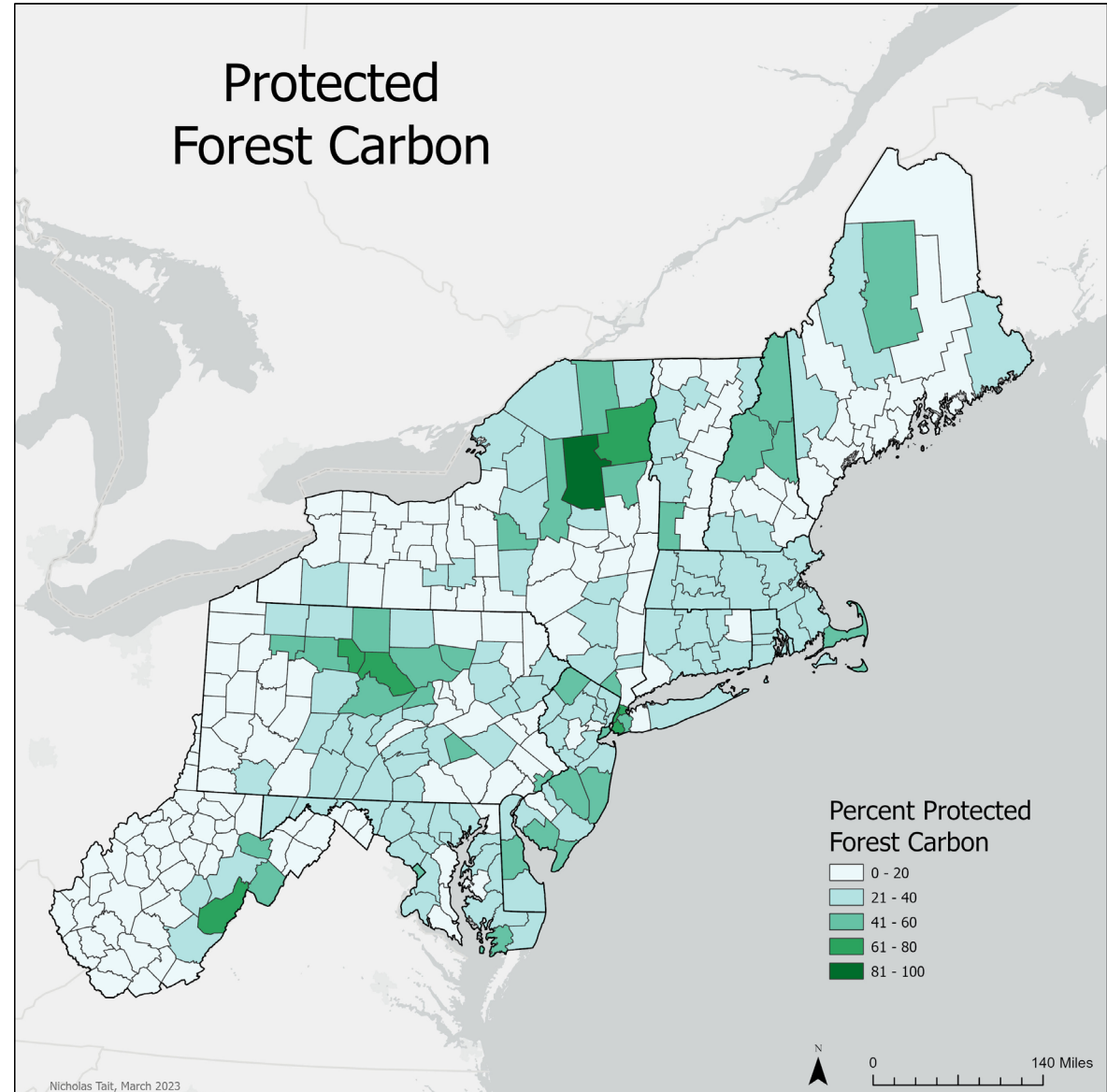| Protected Area Category	Definition
Fee	Land owned outright by public agencies, nonprofits, or private entities--most common way real estate is owned.
Easement	Conservation areas provided by the National Conservation Easement Database (NCED), where legal agreements have been set between landowners and eligible organizations to protect land.
Designation	Policy-designated land that may overlap with other types of protected areas
Proclamation	Tribal lands, military lands, and other congressionally appointed proclamations.
Marine	Outer continental shelf lands managed by the Bureau of Ocean Energy Management and Marine Protected Areas inventoried by the National Oceanic and Atmospheric Administration

Proposed methodology

- Determine the spread of forest carbon by county in the conterminous United States

- Break apart the PAD data into federal protected forest land, nonprofit forest land, and private forest land to determine forest carbon stocks among different protected forest area

- Break apart the Sass et al. dataset into different types of forest ownership to compare those as well

Proposed methodology continued

- Use various geoprocessing tools in ArcGIS Pro to conduct the analysis:
    - *Clip* tool to punch out the various types of protected areas of each county
    - *Zonal Statistics as Table* to determine sum of carbon by county's protected areas
    - *Join* tables of data to counties layer and symbolize to display amount of AGB and BGB carbon levels for forest area type per county
    - Repeat process for every forest protected area type and forest ownership type of interest for the study
    - Statistical tests (linear regression or ANOVA) on results to determine any correlation between forest ownership type and carbon stock

Map from previous forest carbon project

Protected
Forest Carbon

Percent Protected
Forest Carbon
0 - 20
21 - 40
41 - 60
61 - 80
81 - 100

0   140 Miles

Nicholas Tait, March 2023

Project Timeline

Deliverable	Timeline
Map of forest carbon stocks in CONUS	10/23/23-10/30/23
Maps of forest carbon by protected area type	10/30/23-11/6/23
Maps of forest carbon by family ownership type	11/6/23-11/14/23
Analysis of results	11/14/23-11/29/23
Look for gaps in results and fill in methodology as needed	11/29/23-12/13/23
finalize maps and tables for final paper	12/13/23-12/19/23
Introduction	1/3/24-1/10/24
Methodology	1/10/24-1/17/24
Results	1/17/24-1/24/24
Discussion	1/24/24-1/31/24
Conclusion	1/31/24-2/7/24
Compile final draft	2/7/24-2/14/24
Reviewing/editing, start prepping presentation	2/14/24-2/28/24
Create presentation	2/28/24-3/6/24
Practice presentation	3/6/24-3/13/24
Finalize paper and presentation	3/13/24-3/20/24

Presentation Value

- Stakeholders
- Future of science
- My own personal career aspirations

Anticipated Results

- I expect the highest level of aboveground living biomass and belowground living biomass to be concentrated in forests that are more likely to have better management plans

- Public lands will likely have high amounts of carbon stocks

- Private forests will likely show a mix of areas of high carbon and low carbon

- I also expect easements to also have high levels of forest carbon

References and Images

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- Gizachew, B., Solberg, S., & Puliti, S. (2018). Forest Carbon Gain and Loss in Protected Areas of Uganda: Implications to Carbon Benefits of Conservation. Land, 7(4), 138. https://doi.org/10.3390/land7040138

- Sass, Emma M.; Butler, Brett J.; Markowski-Lindsay, Marla A. (2020). *Forest ownership in the conterminous United States circa 2017: distribution of eight ownership types - geospatial dataset*. Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2020-0044

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