

# Long-Term Patterns of Forest Productivity and Nitrogen Availability in a Northeastern US Temperate Forest



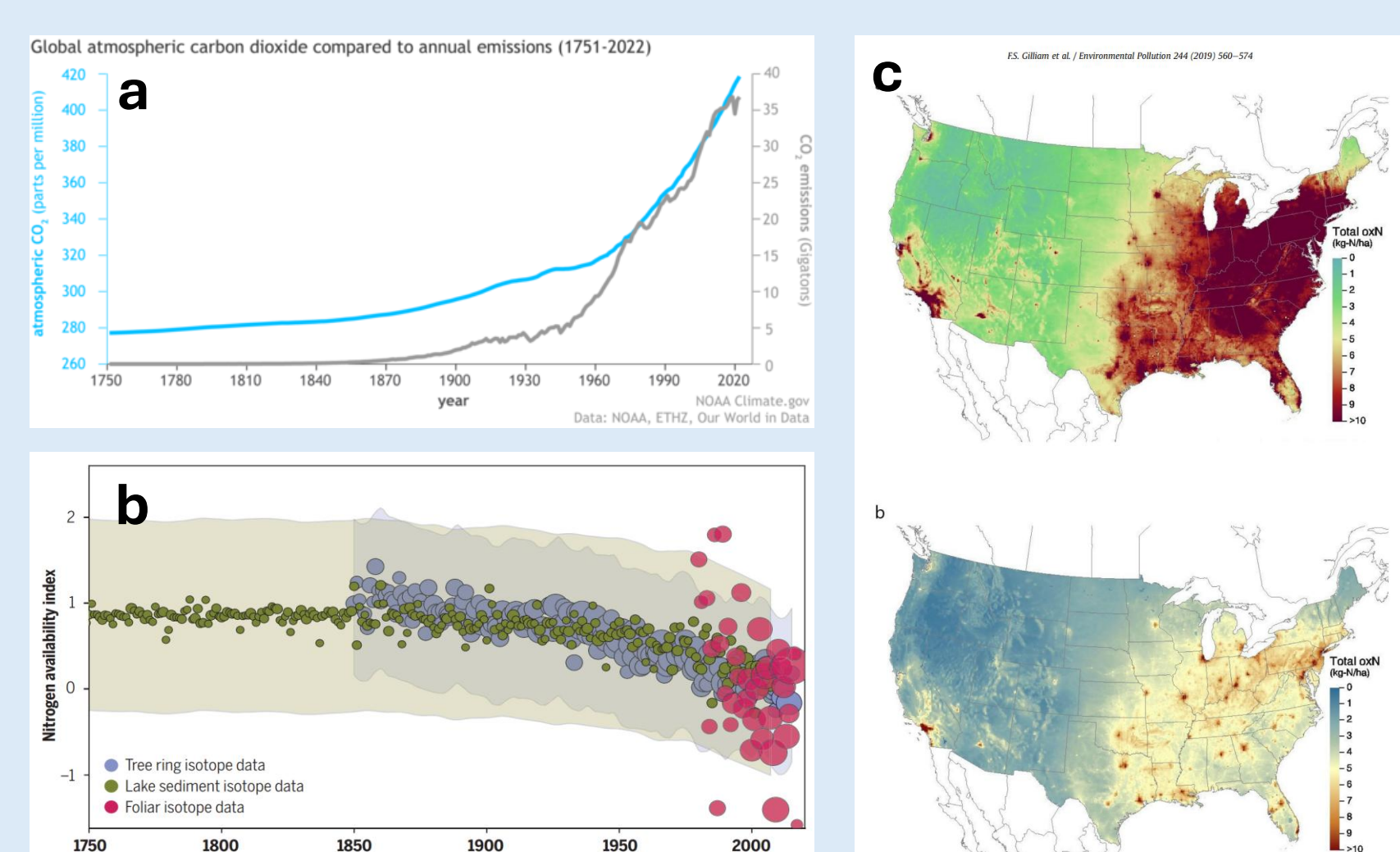
Arielle Kotulak<sup>1</sup>, John Dionis<sup>1</sup>, Serita D. Frey<sup>1</sup>, Andrew Ouimette<sup>2</sup>, Corey Blommel<sup>1</sup>, Jack Hastings<sup>1</sup>, Elijah Tetreault<sup>1</sup>, Vandy Vandewater<sup>1</sup>, Scott V. Ollinger<sup>1</sup>

<sup>1</sup>University of New Hampshire, Durham, NH <sup>2</sup>USDA Forest Service, Durham, NH

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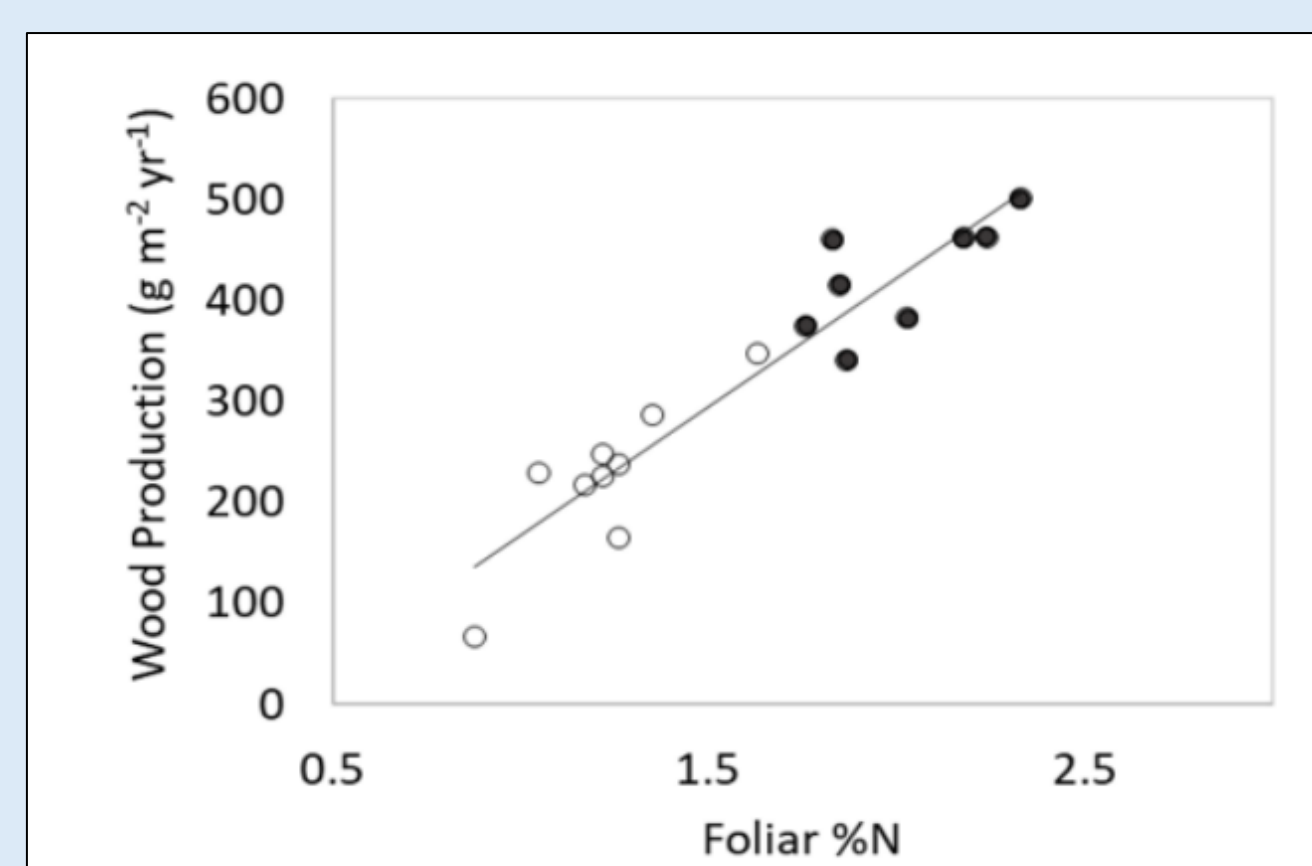
## Background

- Strong linkages between foliar Nitrogen (N, a key limiting nutrient for trees), wood production, and soil N availability<sup>4</sup>.
- Global evidence for declining N availability in some forests, hypothesized that this shift may be influenced by rising CO<sub>2</sub> and declining N deposition<sup>1</sup>.



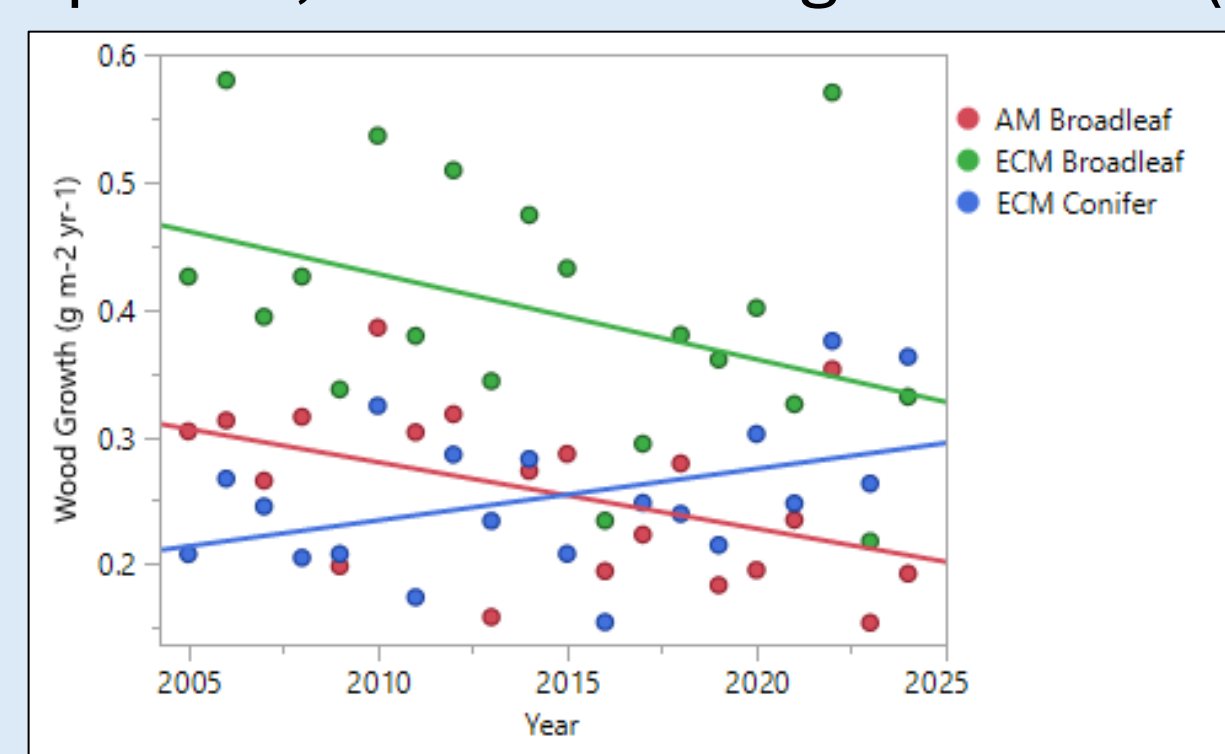
**Figure 1.** (a) Rising global CO<sub>2</sub> emissions<sup>2</sup>; (b) declining global N availability index<sup>1</sup>; (c) declining N deposition from 2000-2014<sup>3</sup>

- Foliar %N historically tracks strongly with wood growth (Figure 2)



**Figure 2.** Relationship between wood production and foliar %N, based on data collected at BEF 1991-1998<sup>4,5</sup>

- In parts of the Bartlett Experimental Forest (BEF), wood growth rates have been flat or declining for some species, and increasing for others (Figure 3)



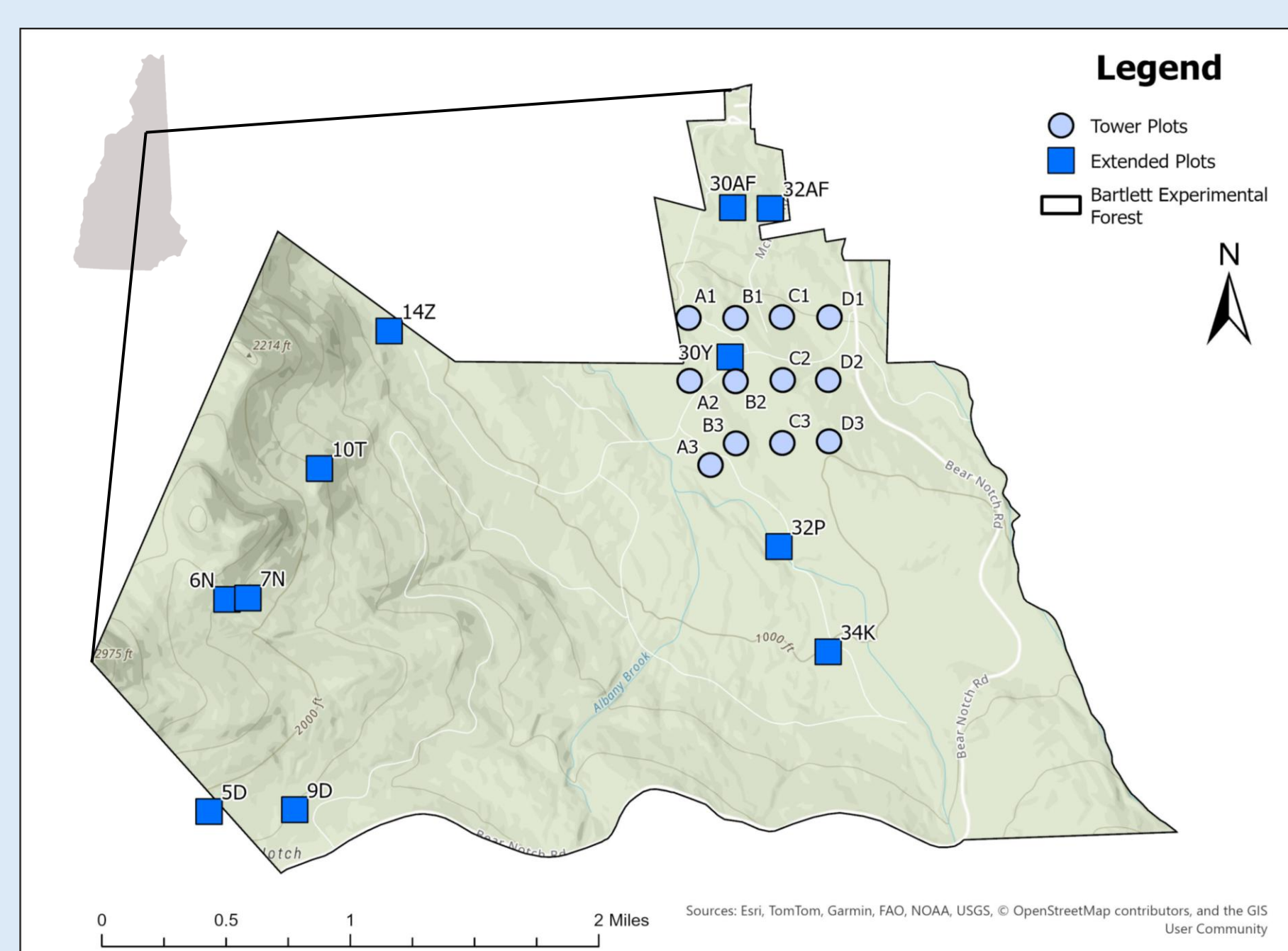
**Figure 3.** Wood growth rates over the last two decades for three functional groups in a portion of BEF

## Research Question:

Has the relationship between wood growth and foliar N changed over the last 25+ years?

## Study Area

### Bartlett Experimental Forest (BEF), White Mountains, New Hampshire



**Figure 4.** Map of BEF

- 1,052-hectare forested research site
- Mean stand age ~115 years
- 11 plots selected from 500 USFS permanent inventory plots
- 12 plots surrounding eddy covariance tower measuring CO<sub>2</sub> exchange since 2004
- Resampling these 23 plots to evaluate key changes at BEF over the last 25+ years

## Methods

### Wood Growth

- Diameter measurements from trees and saplings from multiple years scaled to plot level using allometric biomass equations<sup>6</sup>



### Foliar Nitrogen

- Dominant species leaves obtained via shotgun sampling
- Leaves measured for %N and δ<sup>15</sup>N
- Scaled to plot level by relative biomass using camera-point quadrat method<sup>7</sup>



**Below:** various N availability and belowground C allocation indicators (soil C:N, litterfall C:N, foliar δ<sup>15</sup>N, soil respiration) to contextualize potential changes to leaf chemistry and/or wood production.

### Soil Respiration

Soil respiration collars measured with a LiCOR LI870 every ~3 weeks during snow-free portion of the year.



### Soil C:N

Soil cores (organic + top 10cm mineral) from each plot measured for C:N, a common soil organic quality metric linked to soil N availability<sup>1</sup>.

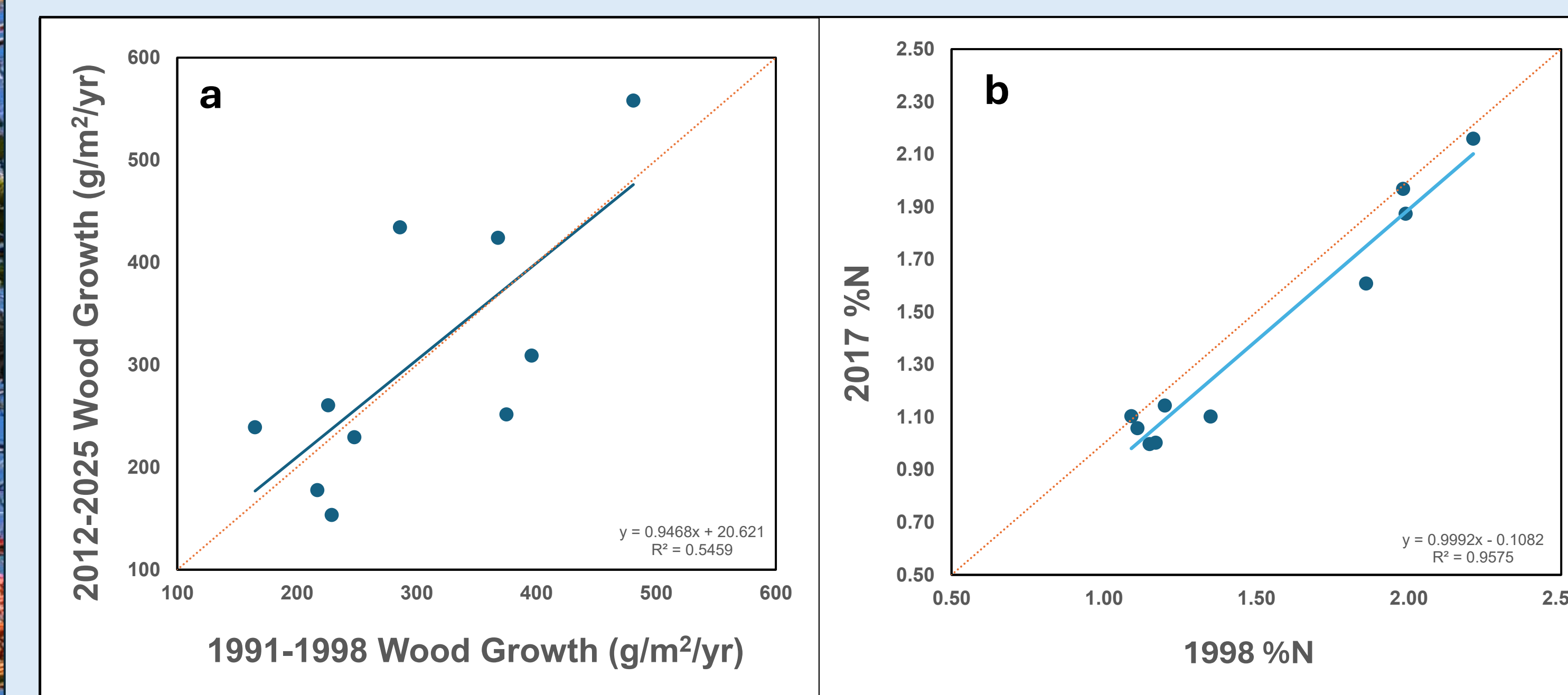


### Litter C:N

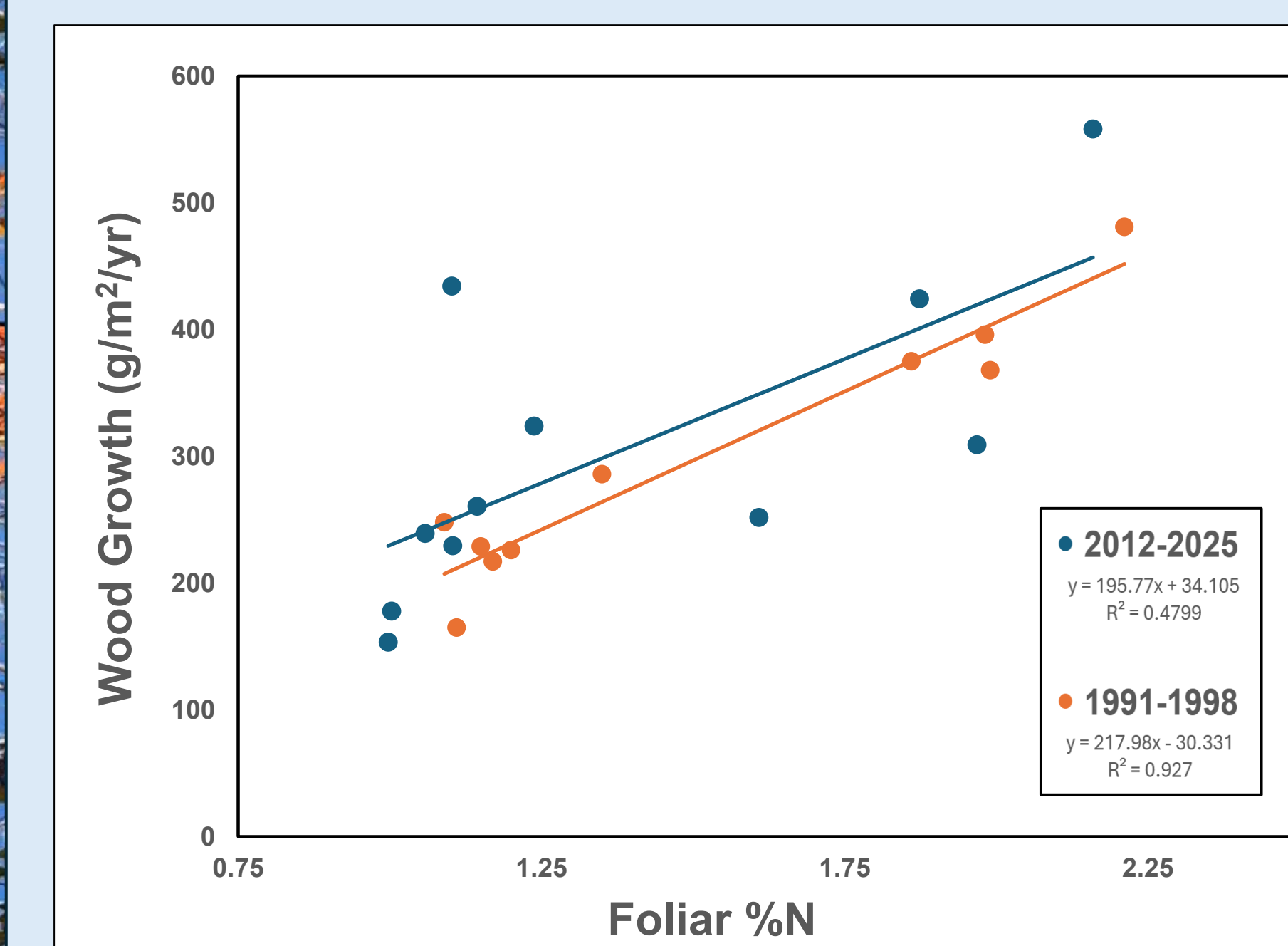
Leaf litter collected from mesh-lined laundry baskets in the fall, spring, and late summer to be measured for C:N.



## Preliminary Results



**Figure 5.** (above) (a) Plot-level wood growth rates from 2012-2025 compared with growth rates from 1991-1998; (b) Plot-level foliar %N in 2017 compared with %N in 1998.



**Figure 6.** (left) Relationship between plot-level wood growth and foliar %N for 2012-2025 vs. 1991-1998.

## Next Steps

- Obtain 2025 foliar %N, foliar δ<sup>15</sup>N, soil C:N, and litter C:N via Element Analyzer and Isotope Ratio Mass Spectrometer
- Examine species-specific and functional group trends in wood growth rates and foliar %N
- Process soil carbon flux data and scale to an annual respiration rate, to be compared with wood growth rates as a proxy for the ratio of above- to belowground carbon allocation

## Acknowledgements

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Questions/comments: arielle.kotulak@unh.edu

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