Effects of Nutrients on Foliar Characteristics of Pin Cherry, American Beech, Yellow Birch, and White Birch

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Introduction

Physical properties of tree leaves can indicate forest health and productivity and can be used to predict decomposition rates. Increasingly, leaf dry matter content (LDMC, the ratio of leaf dry mass to fresh mass) is used as an indicator of a plant resource strategies. Monitoring LDMC may give indications or predictions about the change in forest ecosystems over time.

Research funded through the National Science Foundation is investigating nutrient acquisition and limitation on hardwood forests. The Multiple Element Limitation in Northern Hardwood Ecosystems (MELNHE) project focuses specifically on nitrogen (N), phosphorus (P), and calcium (Ca) manipulation at Hubbard Brook, Jeffers Brook, and Bartlett Experimental Forests in the White Mountains of New Hampshire. Species of interest are pin cherry *(Prunus pensylvanica)*, American beech (*Fagus grandifolia)*, white birch (*Betula papyrifera*) and yellow birch (*Betula alleghaniensis)*.

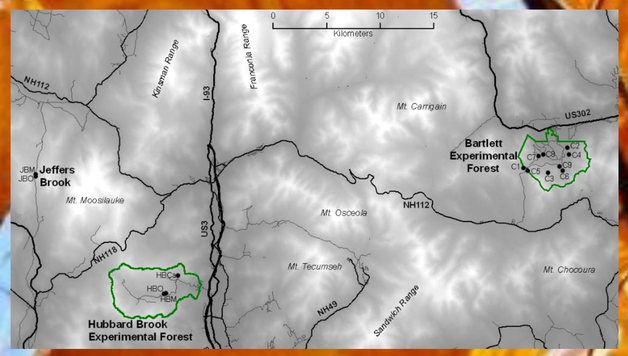
Materials and Methods

Stands were selected in three age classes of yound, mid, and old (26-38 years, 41-46 years, and 100-127 years; See Table 1 below). Bartlett has contained three replicate stands of each age class, and Hubbard Brook and Jeffers Brook each had one mid-aged and mature stand. In each stand, there were four treatment plots, each a quarter hectare except for mid-aged stands at Jeffers Brook and Hubbard Brook. treated with N (30 kg/ha/yr as NH4NO3), P (10 kg/ha/yr as NaH2PO4), N+P, and control. At 5 of the 13 stands, we also have a Ca treatment plot (3500 kg/ha as CaSiO3) that was applied in spring 2011.

Pin cherry, American beech, white birch, and yellow birch were sampled from each plot during the first two weeks of August 2016 using a 12 gauge shotgun. Because leaf collection has been ongoing since 2004 we collected leaves from trees that had been previously sampled whenever possible. The goal was to gather a sample of at least 10 healthy, sun-exposed leaves. Sampled leaves consisted of the blade and petiole with minimal herbivory, shot holes or tears, with healthy and consistent pigmentation, and with any insects, webs, and axillary buds and stipules removed. Samples were then frozen.

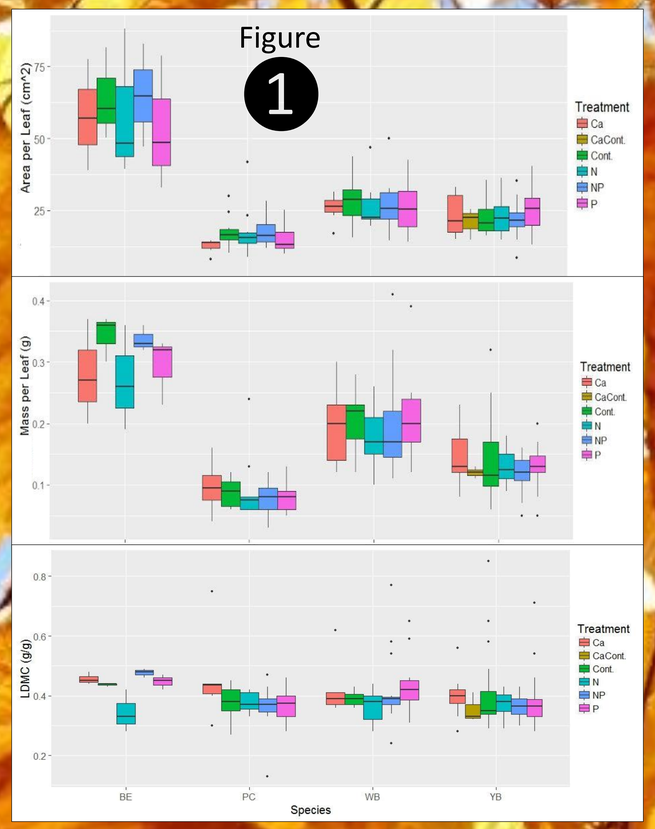
Table 1. Site descriptions for the Huntington Wildlife Forest (HWF), Hubbard Brook Experimental Forest (HBEF), and Bartlett Experimental Forest (BEF).

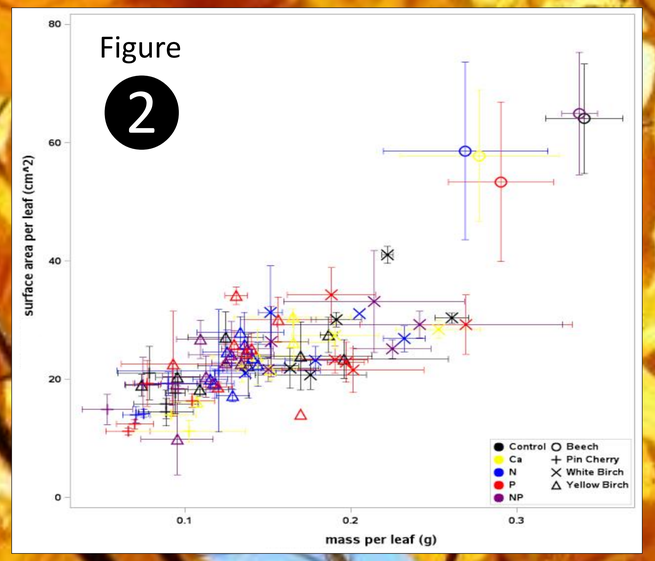
Studies	Stands	Year cut	Latitude (N)	Longitude (W)	Elevation (m asl)	Aspect	Slope (%)	Dominant overstory vegetation	Basal area ($m^2 \cdot ha^{-1}$)
HWF	IFS hardwood site	~1915	43°59′	74°14′	530	NE	5–15	American beech, sugar maple, red maple	26
HBEF	Base of W7	~1915	43°56′	74°45′	689	NE	12–14	American beech, sugar maple, yellow birch	26
BEF	C1	1990	44°02′	71°19′	570	SE	5–20	Pin cherry, white birch, American beech	12
	C2	1988	44°04′	71°16′	340	NE	15–30	Red maple, American beech, white birch	15
	C4	1979	44°03′	71°16′	410	NE	20–25	White birch, pin cherry, red maple	26
	C6	1975	44°02′	71°16′	460	NNW	13–20	White birch, pin cherry, red maple	27
	C9	1890	44°03′	71°17′	440	NE	10–35	American beech, sugar maple, yellow birch	30
	C8	1883	44°03′	71°18′	330	NE	5–35	American beech, sugar maple, yellow birch	32



Data analysis

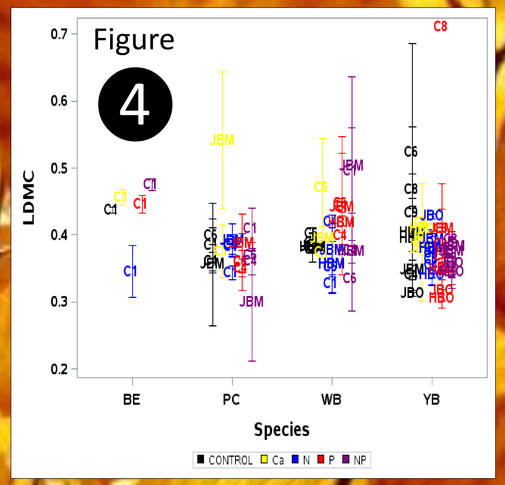
Frozen samples were weighed and dried to obtain wet mass, dry mass, and moisture content. Leaves were imaged and evaluated with ImageJ to calculate specific leaf area (SLA, the one-sided area of a fresh leaf, divided by its oven-dry mass). Samples were ground, ashed, and digested to be used later for nutrient analysis. For N, P, NP, and control we used a 2 way factorial with age, stand, and nutrient treatment as independent variables and species as the dependent variable. For calcium and control we used a 1 way factorial with the same independent and dependent variables.

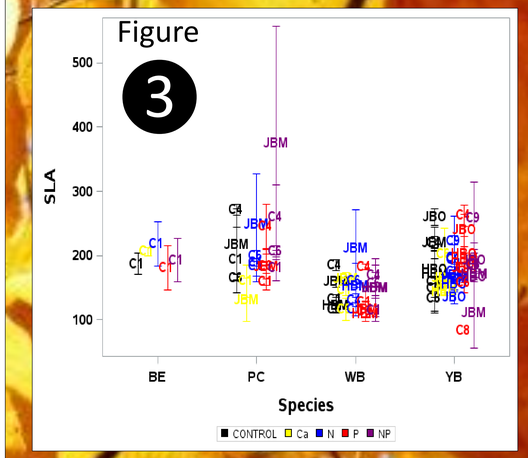




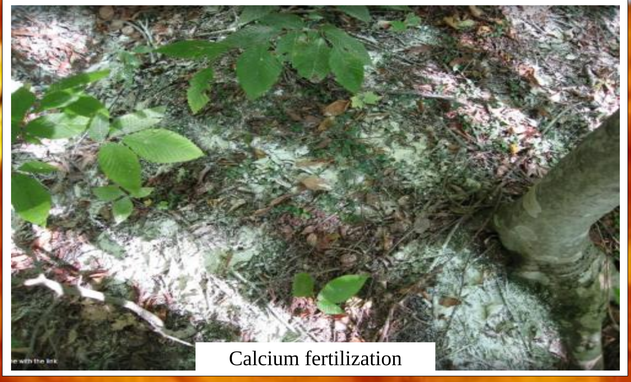
Results

Beech had the biggest area and mass while pin cherry had the smallest. Leaf dry matter content was more consistent across species than other main effects. (figure 1). Leaf mass was correlated to surface area per leaf (figure 2). SLA had no significant main effects due to nutrient treatments, age or stand (Figure 3). Figure 4 shows two different three way interactions between treatment, age, and species. Beech had high moisture content in young stands for nitrogen (P= 0.01), and pin cherry showed a lower moisture content in mid-age stands for calcium (P= 0.02).





Shooting, bagging (top right), imaging (bottom right)



Calcium fertilization

Discussion and Conclusions

- Results showed that few main effects (treatment, age, and species) were significant. Since treatment began 6 years ago it may still be too early to see a treatment effect or to make any speculations, and monitoring will be ongoing.
- The only significant result occurred in LDMC with different species showing altered LDMC across different ages. Because there was no duplication of interaction effects it is difficult to make any broad claims about nutrient manipulations on LDMC. Since effects were noticed in young and mid stands but only for one species and one treatment it will be interesting to monitor this over time to see how mature stands develop. LDMC has been known to correlate positively to leaf lifespan and leaves with high LDMC tend to be tougher and decompose slower, thus be more resistant to physical hazards like herbivory, wind, or hail.
- Collecting and measuring samples long-term presents its own set of challenges when reducing error is considered. There may be tree variability, both across species and individuals, year-to-year fluctuations of nutrients, weather factors, and laboratory error.

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