INTERSPECIFIC DIFFERENCES IN N MINERALIZATION RATES AND STEMFLOW CHEMISTRY AMONG RED MAPLE AND UPLAND OAKS

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Background

- In deciduous forests of the eastern U.S., modification of the historical fire regime has facilitated the spread of red maple (*Acer rubrum*).
- This fire-intolerant, but highly adaptable species is poised to replace ecologically important oaks (*Quercus* spp.).

- A RELATIVELY UNEXPLORED CONSEQUENCE OF THIS APPARENT SHIFT IS HOW INTERSPECIFIC DIFFERENCES IN LEAF AND CANOPY TRAITS CAN AFFECT ECOSYSTEM PROCESSES LIKE NUTRIENT INPUTS AND CYCLING.

Sampling

- Litter input from autumn leaf fall.

1-m² mesh screens 0.5 m from bole.

Litter retrieved weekly during leaf fall 2006.

Litter air-dried at room temperature.

Sorted to species and weighed.

- Throughfall and stemflow during discreet precipitation events.

Polyurethane collars installed on each tree ~ 1.5 m above ground.

Collars connected with tubing to 20-L bin. Two 20-cm diameter throughfall funnel collectors installed 0.5 m from tree bole.

Precipitation collectors in nearby open areas.

Samples collected within 72-hr of event and analyzed in lab for N and C.

- *In situ* net N mineralization using intact core method.

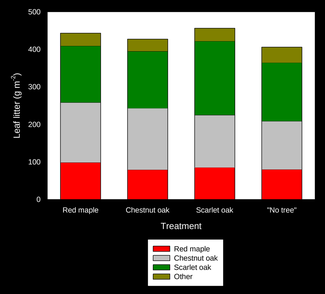
Cores collected at 10-cm depth, 0.5 m from tree bole.

Two cores left *in situ* for 28-d incubation.

Top 5-cm of mineral soil collected from two additional cores for initial N level.

Initial and incubated cores extracted with KCl to determine N cycling rates.

Litter Input



- Tree species identity reflected litter inputs, e.g., red maple received the most red maple litter.
- However, there were no significant differences in leaf litter inputs between treatments.

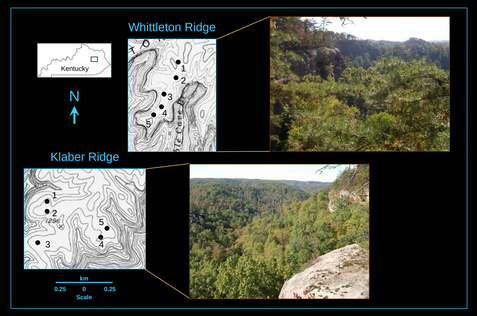
Objectives

Our primary objective was to determine sources of variation among individual red maple and upland oak trees along two ridges in the southern Appalachians of eastern Kentucky with regard to the following:

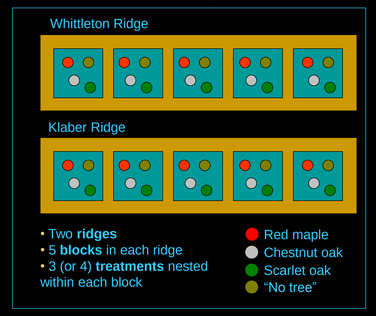
- Litter inputs from autumn leaf fall.
- Throughfall and stemflow quantity and chemistry during discreet precipitation events on a seasonal basis.
- Seasonal *in situ* net nitrogen (N) mineralization within underlying mineral soils.

Study Area and Design

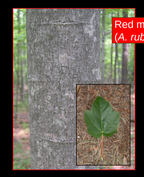
Study Sites

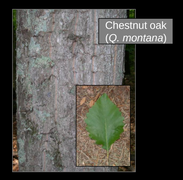


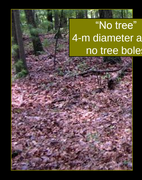
Experimental Design



Treatments







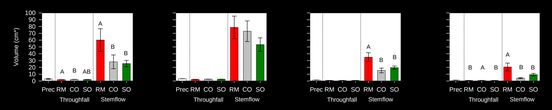
Stemflow and Throughfall

Canopy

Aug '06 Full Canopy (4.22 cm) | Oct '06 Leaves turning; some dropped (3.45 cm) | Feb '07 No leaves (1.12 cm) | May '07 Freshly leafed out (1.22 cm)

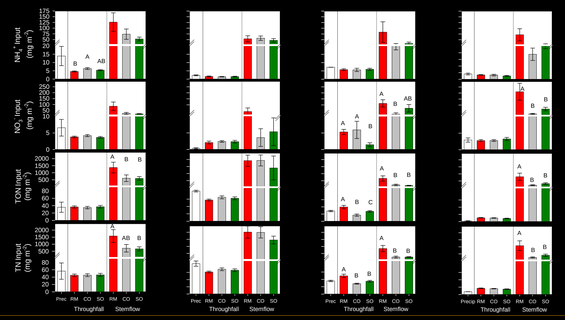
- Rainfall events occurred during various canopy stages and were of different magnitudes.

Volume



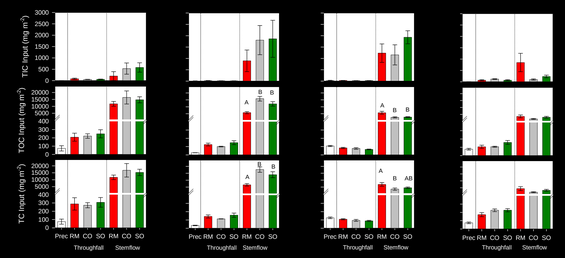
- Throughfall volume was less for red maple in summer and higher for chestnut oak in winter.
- Overall, red maples generated more stemflow.

Nitrogen



- In general, red maples deposited more inorganic and organic nitrogen via stemflow, except during fall.
- Red maples also generated more nitrogen via throughfall in winter.
- Most nitrogen delivered to soils was organic in nature.

Carbon



- Oaks generated higher carbon inputs via stemflow in fall, but red maple produced more organic carbon in winter.

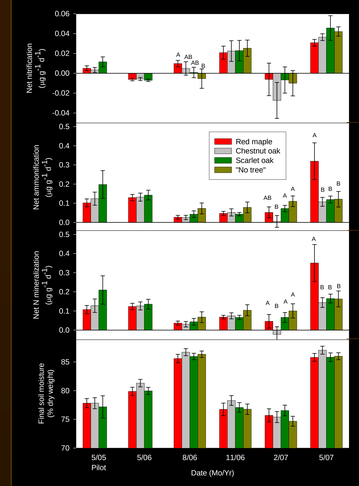
Red maple | Scarlet oak | Chestnut oak

- Different capital letters represent significant differences ($p < 0.05$) across treatments.
- Throughfall and stemflow samples were analyzed separately.

Precipitation
Red maple
Chestnut oak
Scarlet oak

- *Volume and inputs were calculated per unit collecting area, which is the funnel area for precipitation and throughfall and the tree basal area for stemflow.
- Error bars are ± Standard Error. n = 10.

N Mineralization



- Nitrification varied seasonally, but rarely differed among treatments.
- Ammonification was often similar among treatments. However, chestnut oak rates were lower in winter '07, and red maple rates were 2.5x higher than other treatments in spring '07.
- N mineralization was driven mostly by ammonification; thus, trends were similar to those above.
- Gravimetric soil moisture at the end of each incubation period varied seasonally, but not among treatments.

- "No tree" data were not acquired until summer 2006.
- Error bars are ± Standard Error.

Special Thanks to…

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Forest Service U.S. Department of Agriculture

UK University of Kentucky College of Agriculture Department of Forestry

UK University of Kentucky College of Arts and Sciences Department of Biology

Conclusions

- The contribution of red maple, chestnut oak, and scarlet oak leaf litter was not significantly different among treatments.
- Red maples funneled more precipitation and generated greater stemflow volumes.
- Red maples often deposited more inorganic and organic nitrogen via stemflow.
- Oaks funneled more carbon via stemflow in fall, but red maples generated more in winter.
- Red maples ONLY exhibited greater *in situ* net nitrogen mineralization in spring 2007.
- OVERALL, RED MAPLES CAN DIFFER FROM UPLAND OAKS IN THEIR NUTRIENT INPUTS AND CYCLING VIA STEMFLOW AND N MINERALIZATION RATES, SUGGESTING POTENTIAL ECOSYSTEM-LEVEL CONSEQUENCES OF A CANOPY SHIFT.