Fire, successional trajectories, and C pools of boreal forests of interior Alaska

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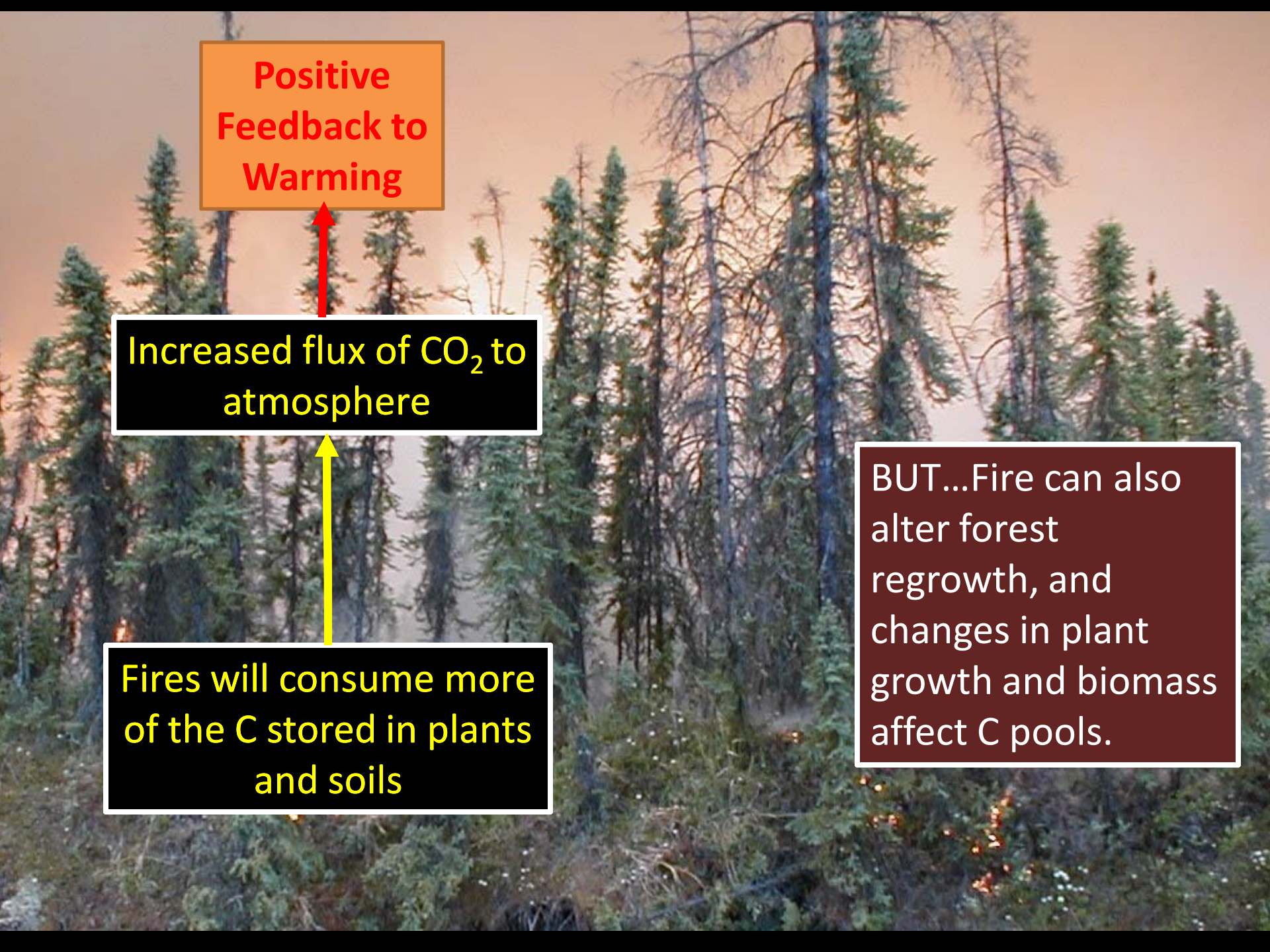
What is the fate of boreal forest C pools under an intensified fire regime?


Positive Feedback to Warming
Increased flux of CO_2 to atmosphere
Fires will consume more of the C stored in plants and soils
BUT…Fire can also alter forest regrowth, and changes in plant growth and biomass affect C pools.

Stand dynamics under an intensified fire regime

- Increased fire frequency could decrease stand age.

↓ C pools

- Increased fire extent could increase distance to seed source, altering stand composition and structure.

? C pools

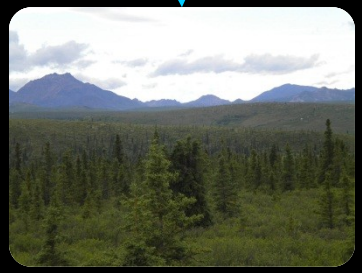
- Increased fire severity could alter soil conditions, germination success, and stand composition and structure.

Cascading Effects of Disturbances

"Novel" disturbance regimes

Change environmental conditions

Reorganize vegetation communities



Shift ecosystem function

Research Question

If increased fire severity leads to a shift in canopy dominance from black spruce to greater deciduous cover, what are the implications for C dynamics?

Approach

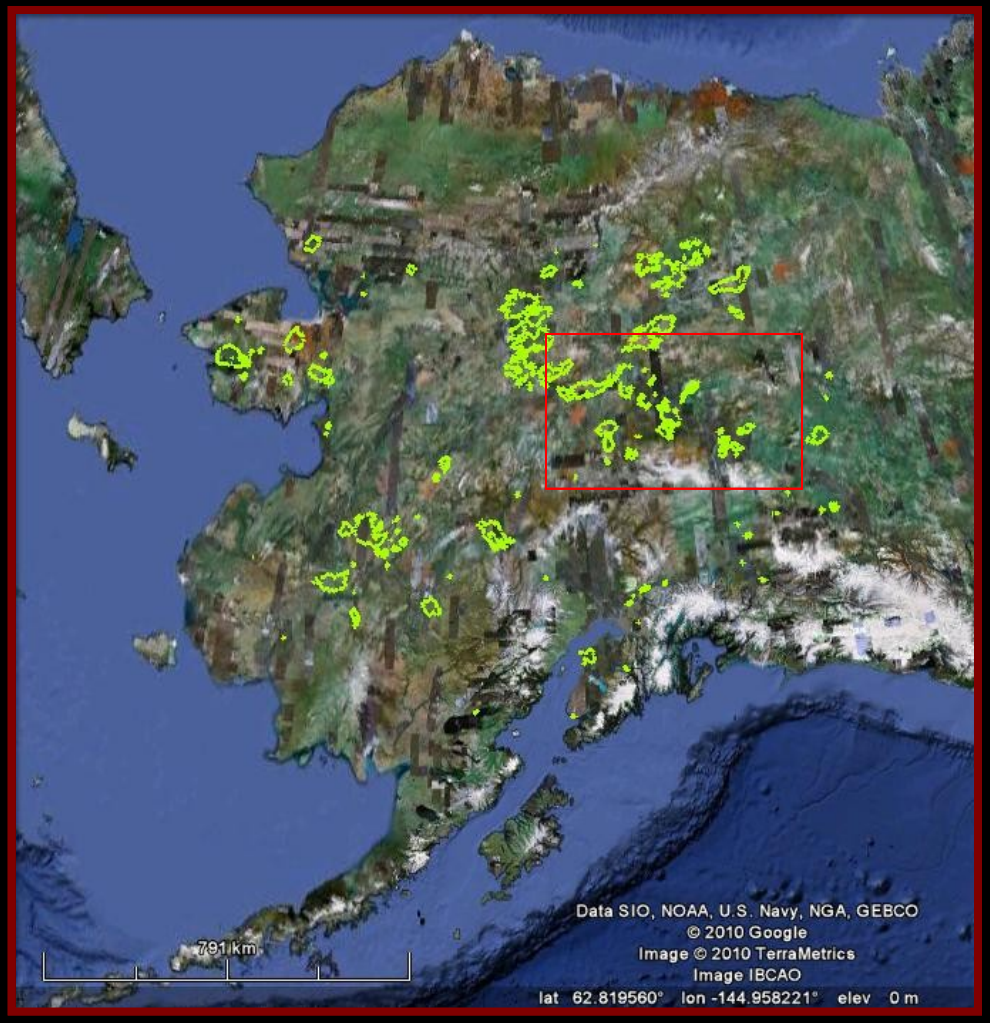
Quantify C pools within mid-successional stands representing a compositional gradient



Black spruce

Deciduous
(aspen or birch)

Site Selection



Intermediate-aged fires
(20 to 59-yr old)

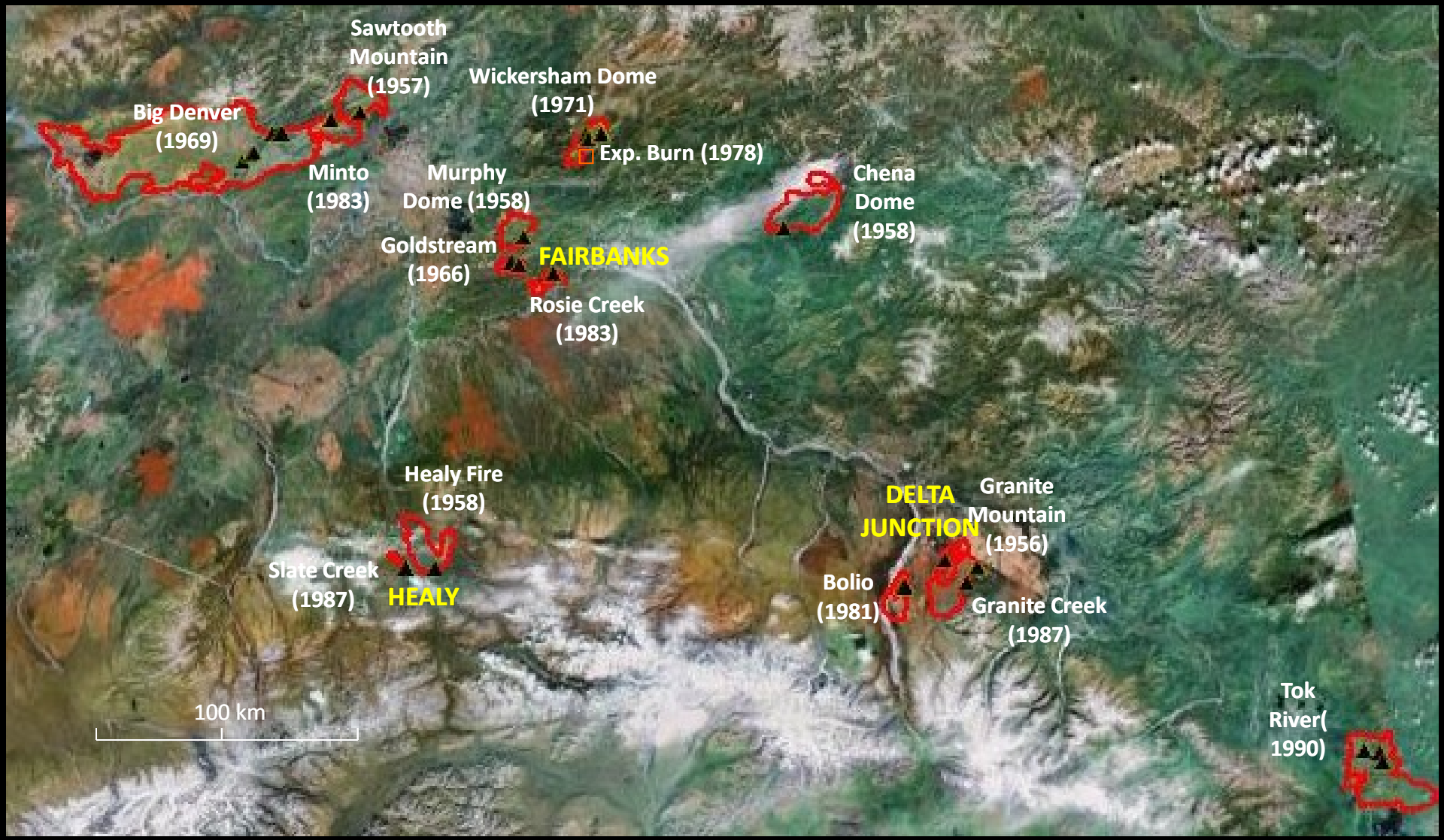
Site Selection

Evidence of previous fire

Signs of potential black spruce origination

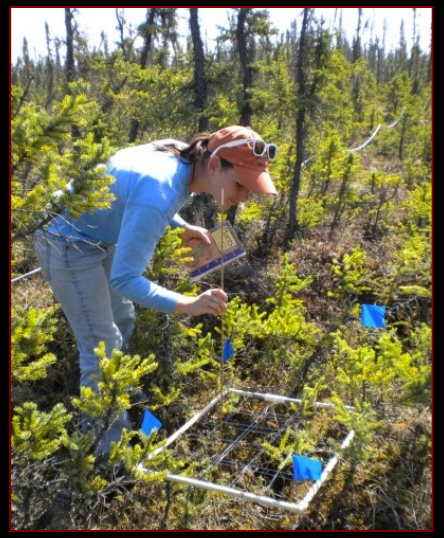
Upland sites of intermediate quality where shift is most likely

Intermediate-aged stands (20 to 59-yr old)



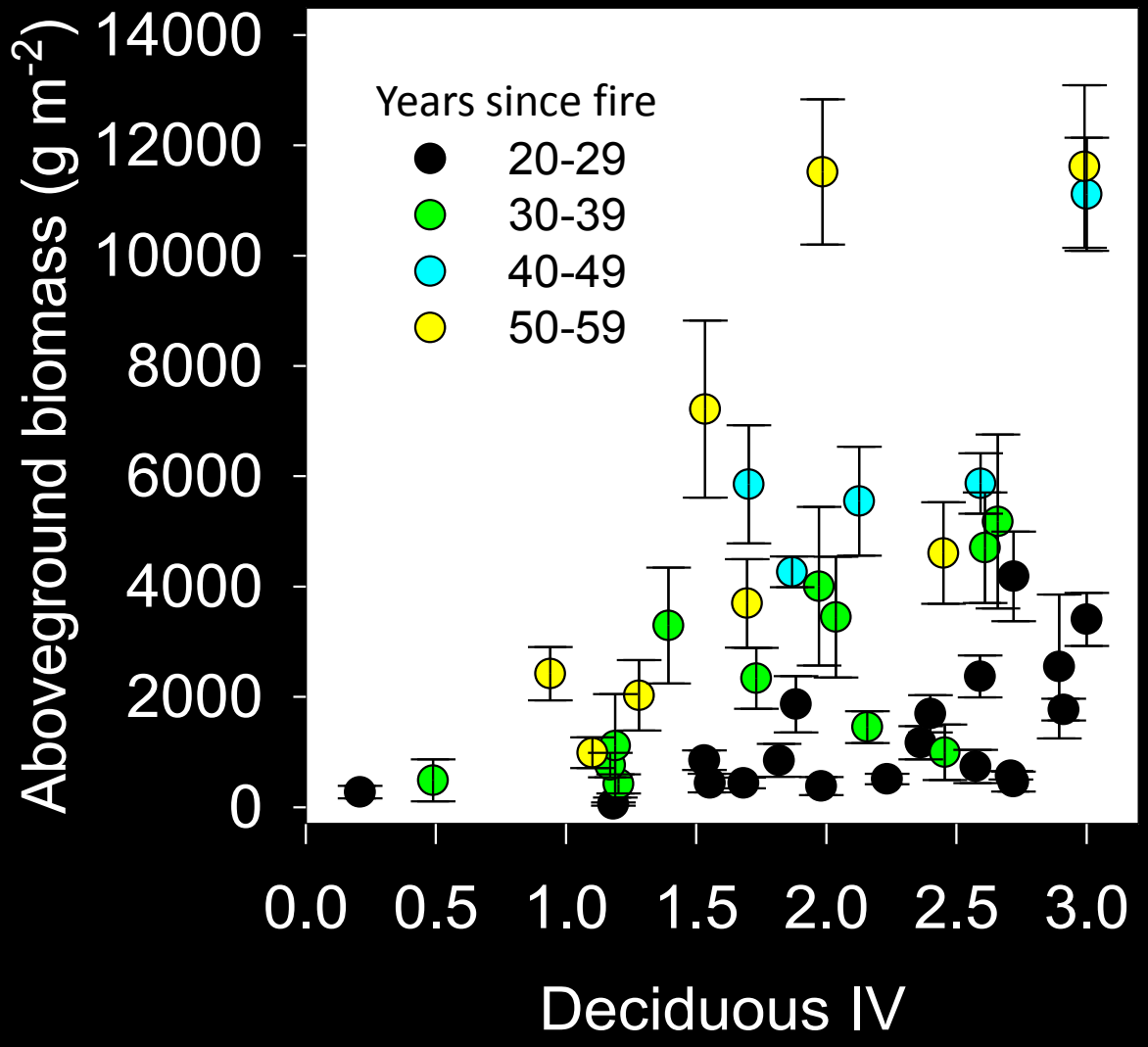
Methods

- Stand structure: density, basal area, composition, leaf area index
- Aboveground tree/large shrub biomass, ANPP, and snag biomass: stand inventory and allometric equations
- Downed woody debris: Line-intercept method
- Understory composition: Grid-intercept
- Stand age: ring counts
- Organic layer and upper mineral soil carbon pools: cores



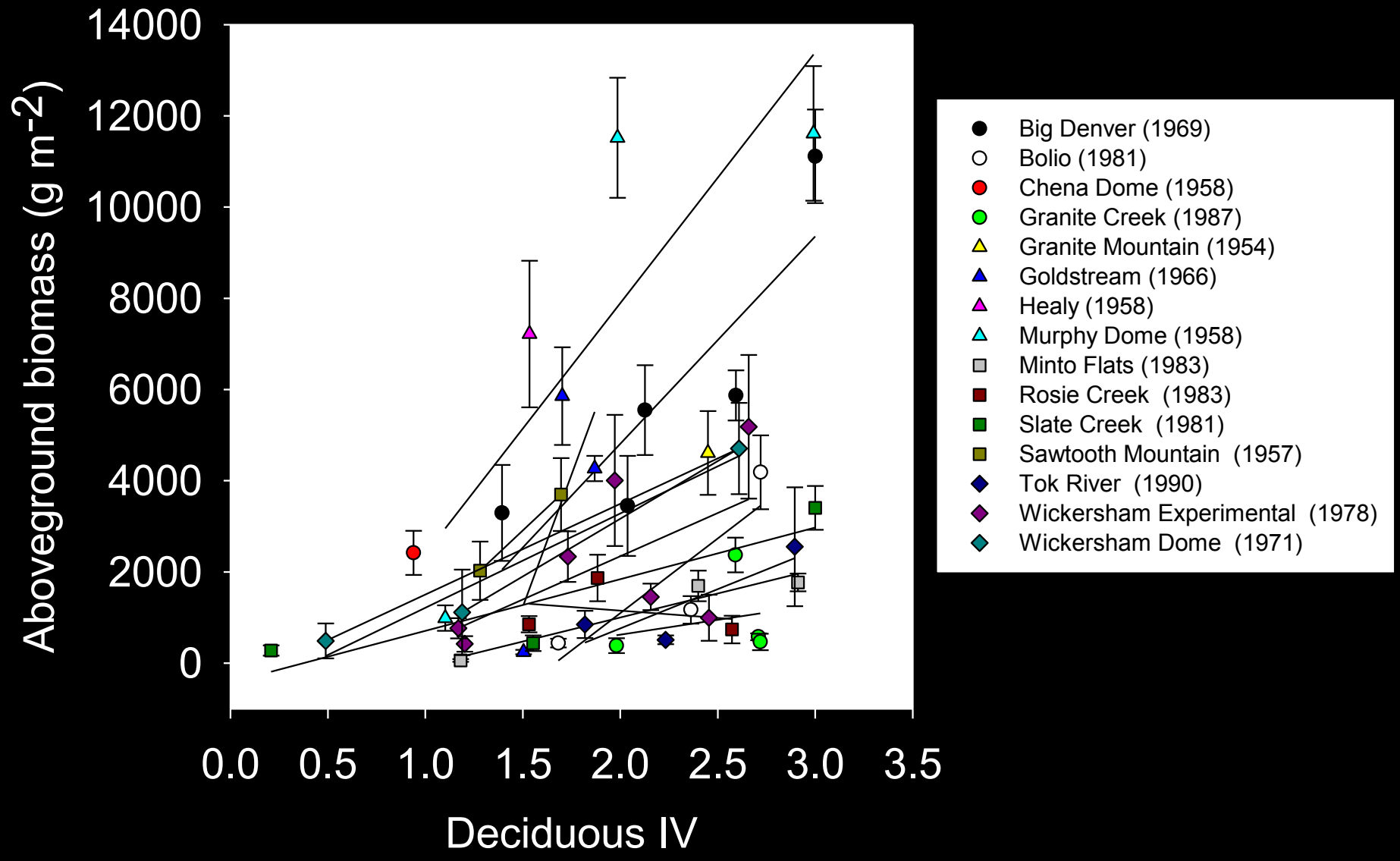
How well can we explain C pools based on deciduous IV and two other potentially important explanatory variables (years since fire and density)?

Aboveground biomass of trees/large shrubs

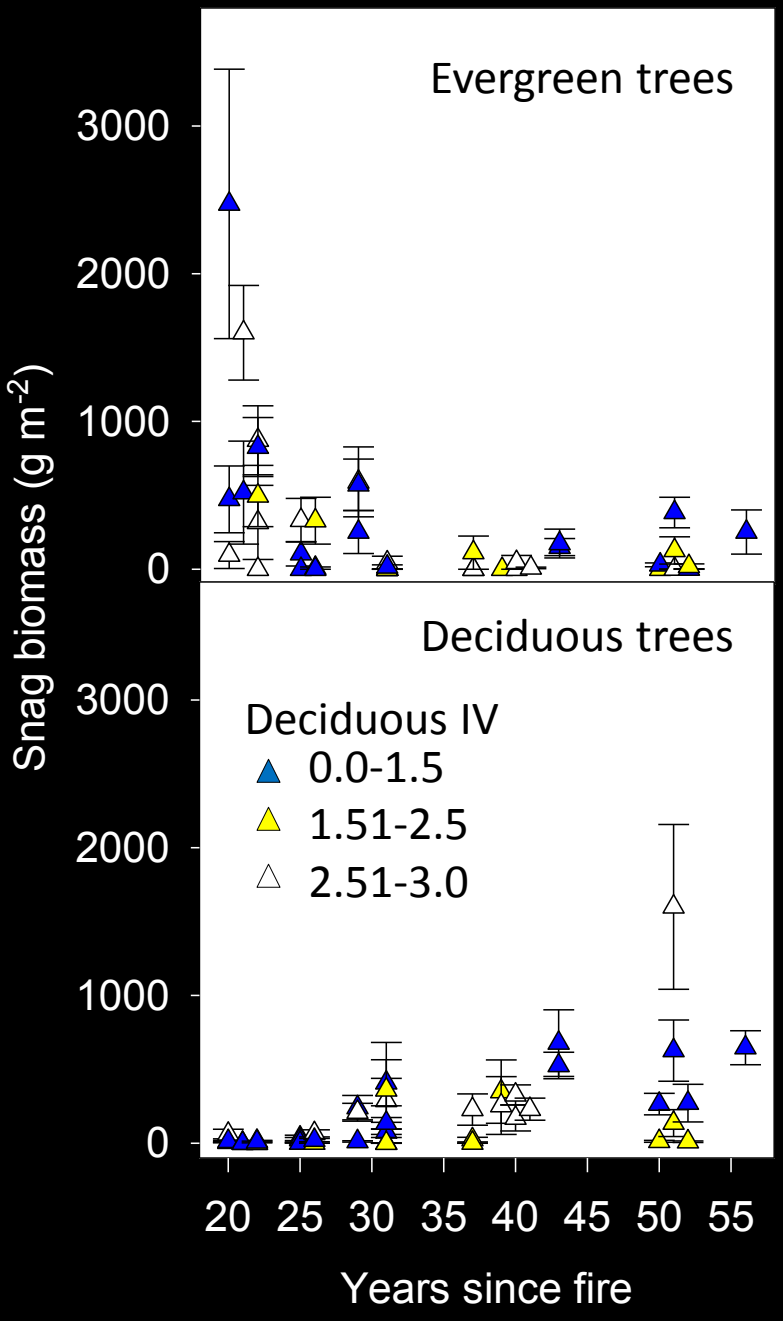


- 64% of variability explained by deciduous IV and years since fire.
- Similar trends in ANPP (48% explained).

Aboveground biomass of trees/large shrubs



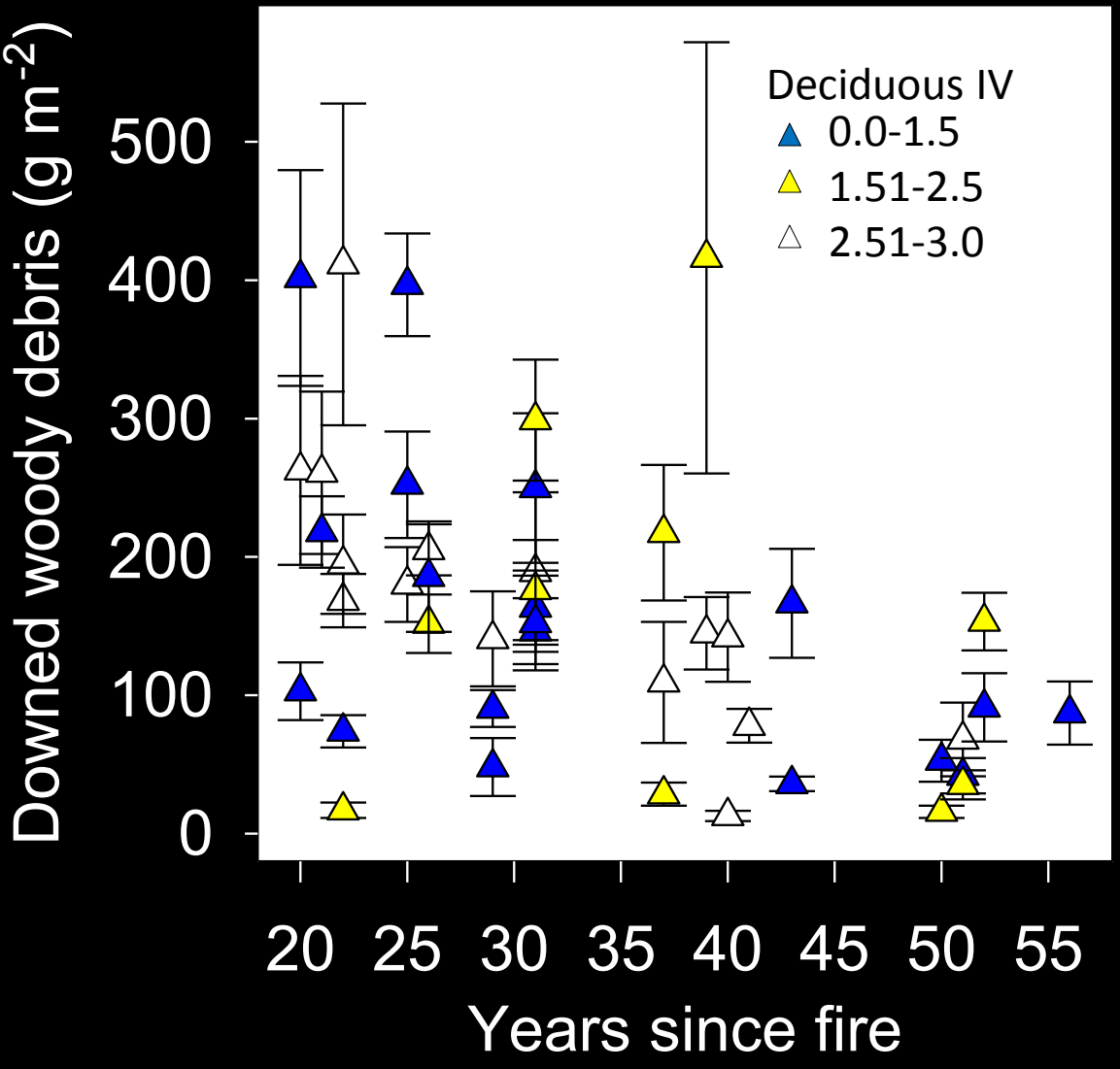
Snag Biomass



- 13% of variability explained by years since fire

- 49% of variability explained by both years since fire, deciduous IV, and their interaction.

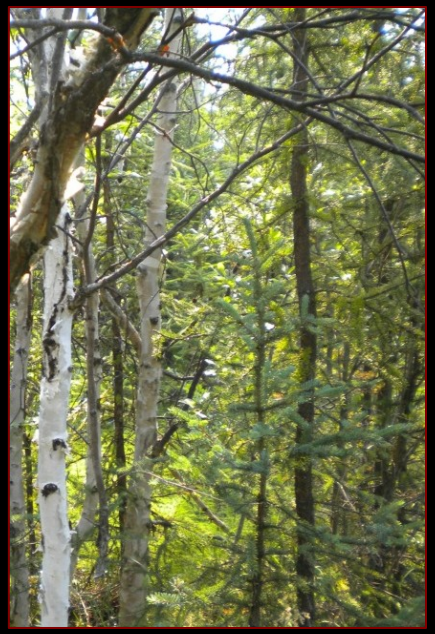
Downed Woody Debris Biomass



- 29% of variability explained by years since fire and density

BUT…
What about differences due to forest type?

Paper birch



Paper birch +
black spruce

Aspen +
black spruce

Black spruce

How does one define forest type?

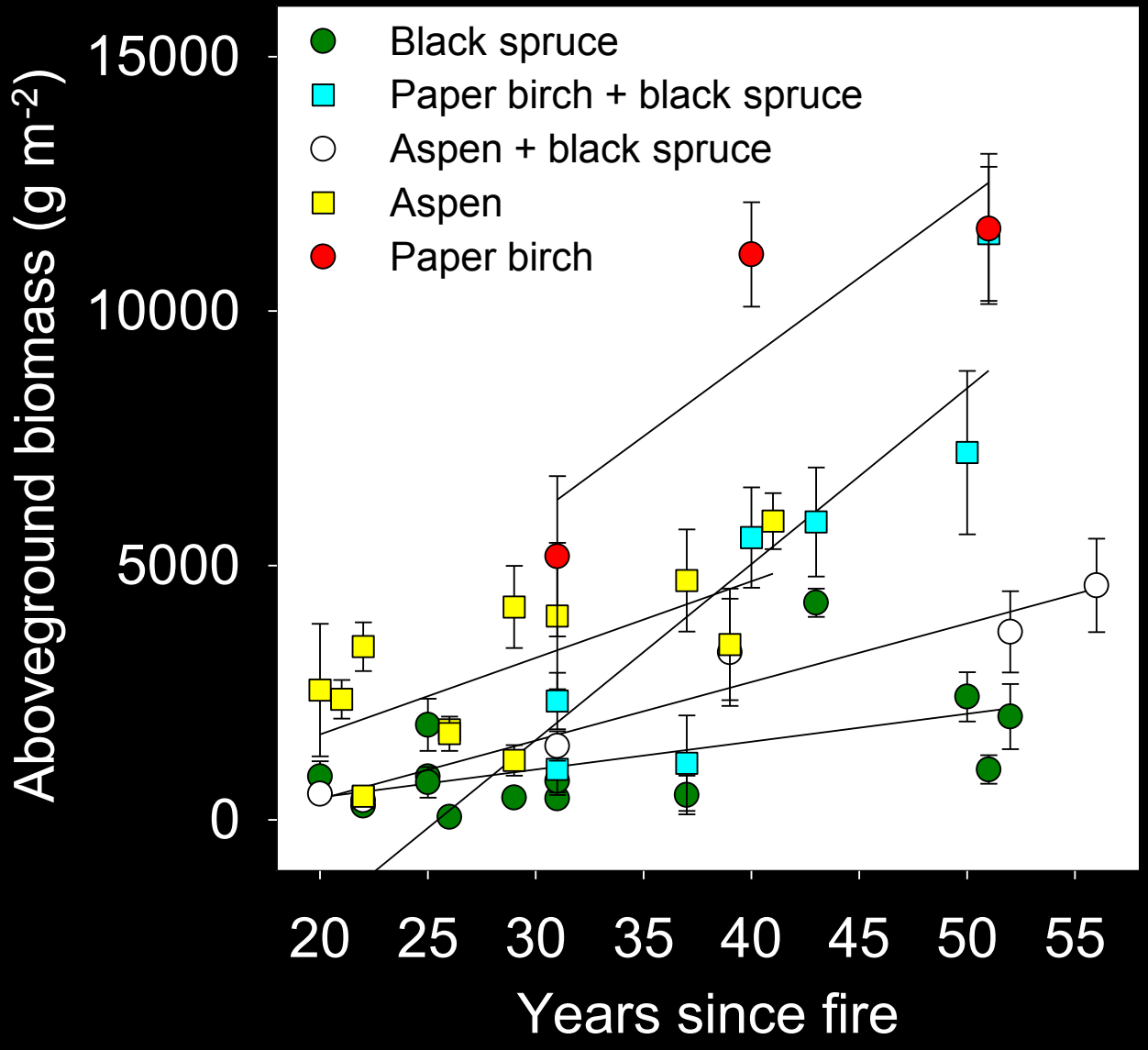
Sometimes a stand is clearly dominated by a single species, but in reality, most stands are mixed.

1) Community analyses?

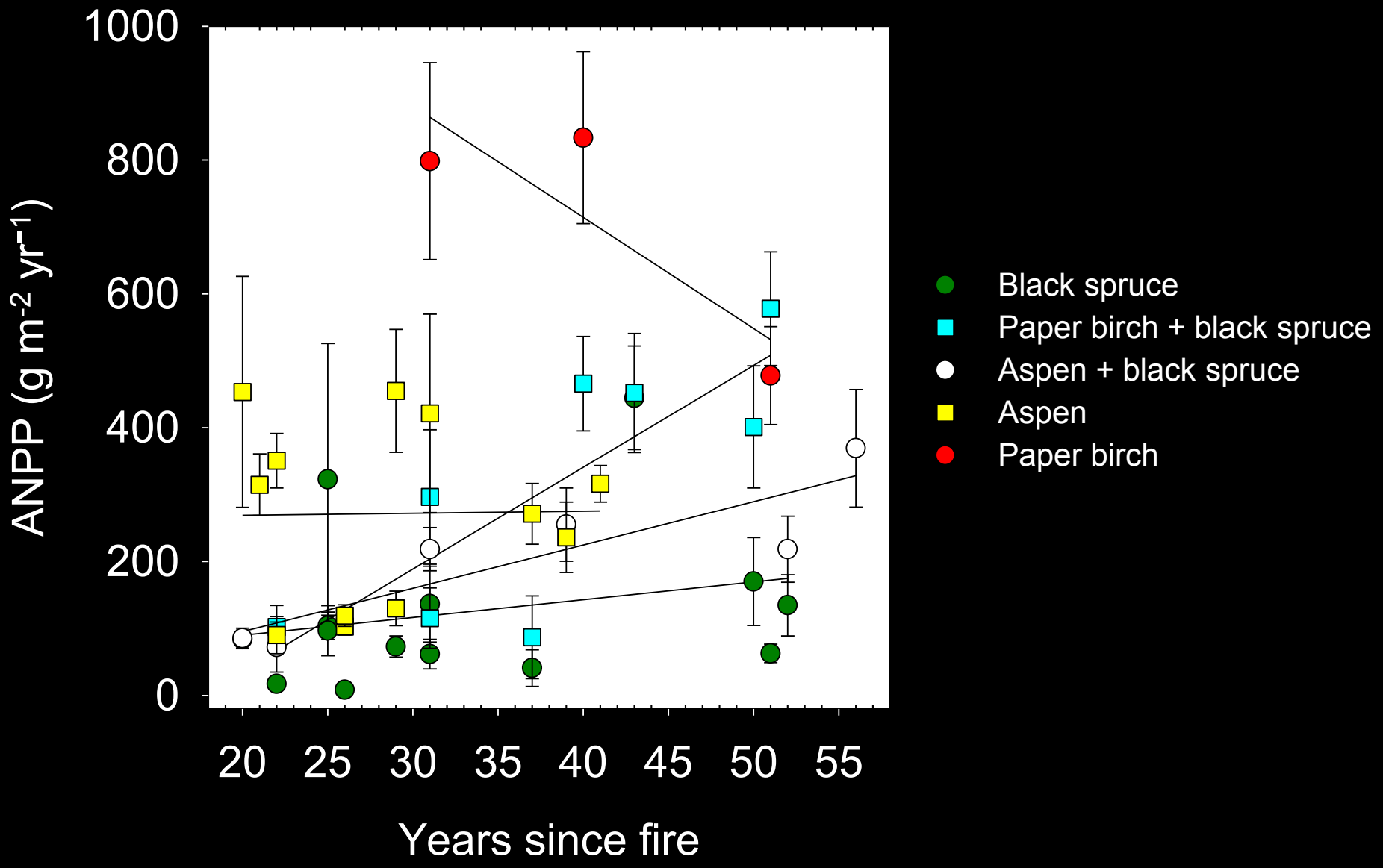
2) Grouping by Deciduous IV?

3) Proportion of stand biomass?

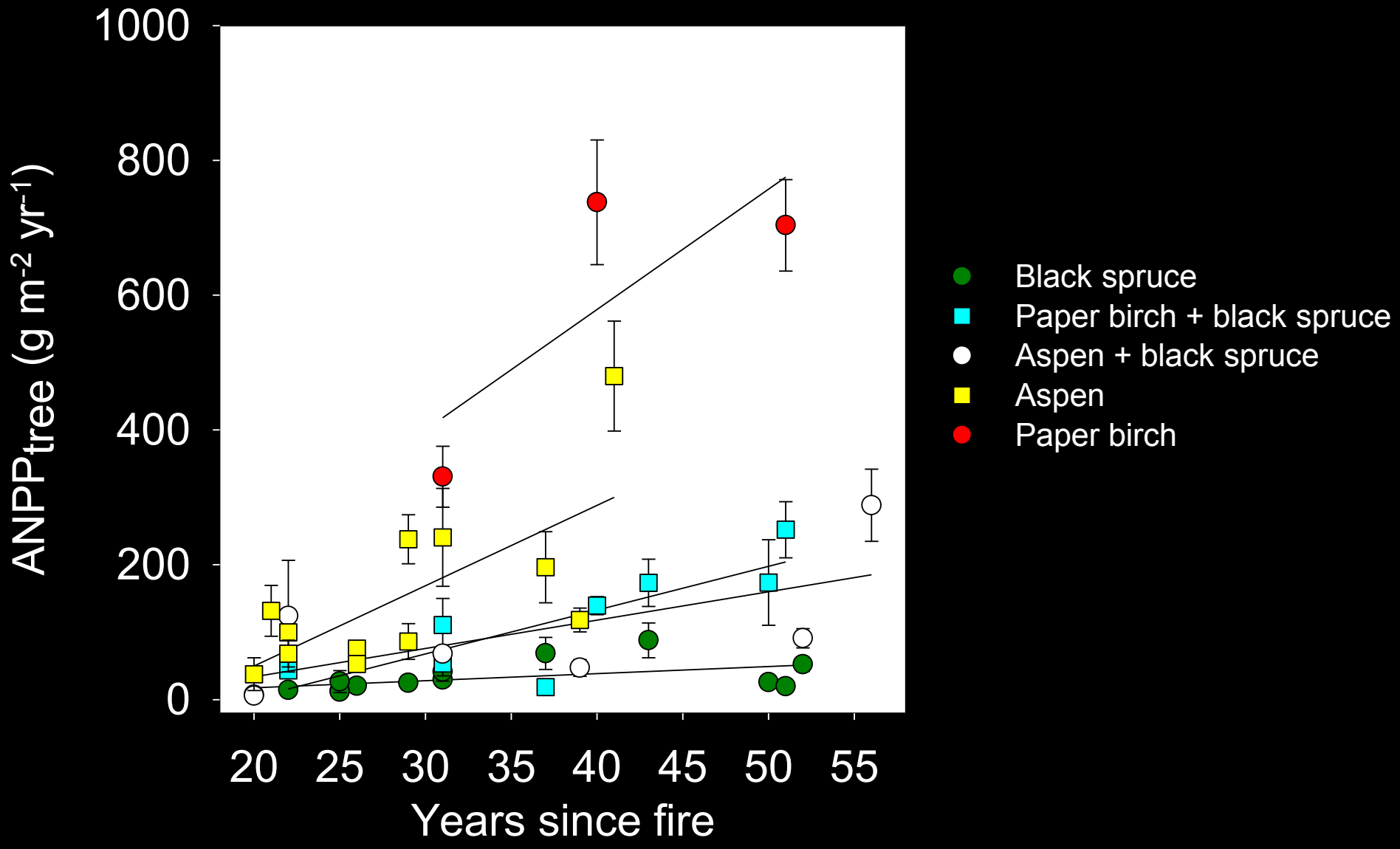
Aboveground biomass by forest type



ANPP by forest type



$ANPP_{tree}$ by forest type

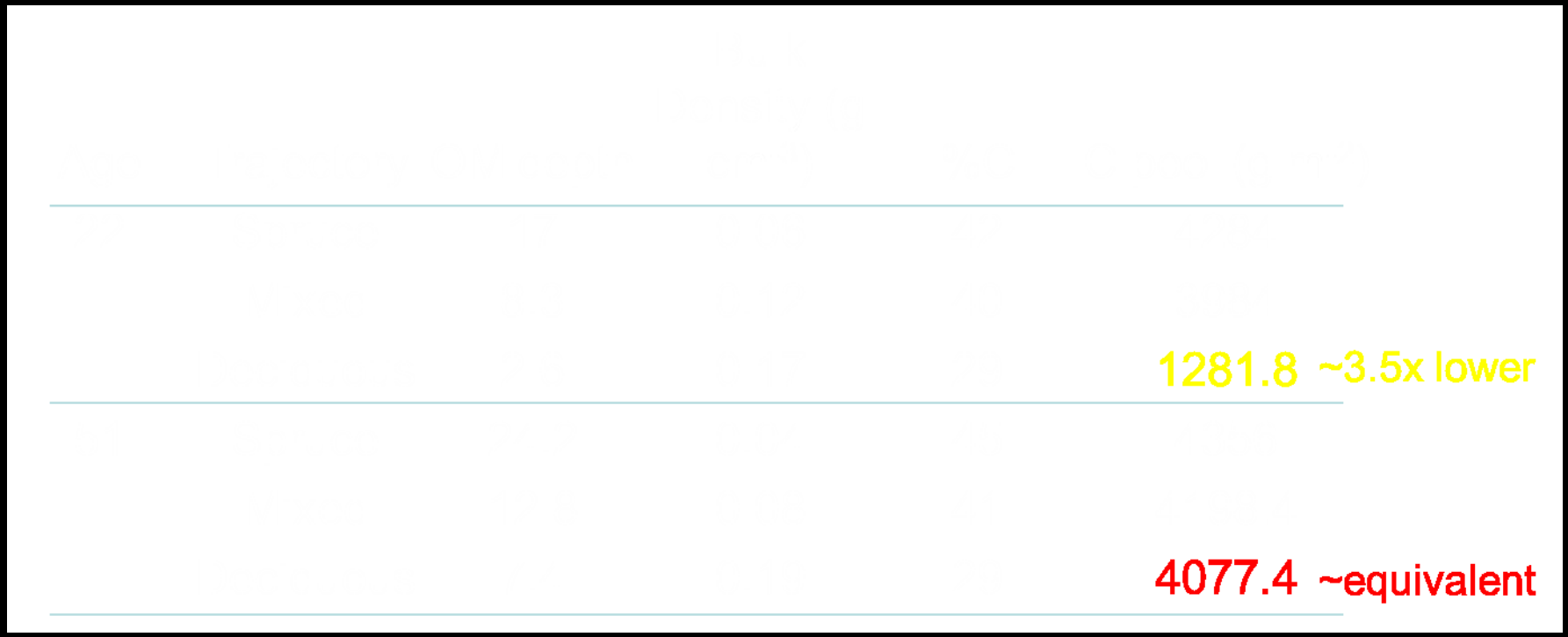


Summary

- Both aboveground biomass and ANPP of trees/large shrubs increased with increasing deciduous IV.
- These increases were inextricably linked to increases due to years since fire.
- There was no effect of deciduous IV on downed woody debris or evergreen snag biomass, which varied mostly with years since fire.
- Deciduous snag biomass increased with increasing deciduous IV, but only in older stands.
- Black spruce stands accumulated and stored less biomass than all other stand types.

Ongoing Work

- Will variations in soil C pools compensate for differences in aboveground C pools?



Ongoing Work

- Are changes in C pools associated with shift in canopy composition sufficient to offset C lost to the atmosphere during the fire disturbance?

- What is the fate of C pools as mixed and deciduous stands mature?

Acknowledgements

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Questions?