Ecology and Dynamics of Aspen in Fire-Dependent Communities across the Lake States and North Atlantic Region

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Audio will start at 2 PM Eastern / 1 PM Central

This webinar is listen only - please use the chat box for to ask questions

Outline

- Review of aspen silvics
- Historic distribution and ecology of aspen across Lake States and North Atlantic
- Aspen developmental pathways and disturbance response across sites
- Integrating structural legacies in aspen silviculture
- Final points

Aspen silvics

Aspen silvics

Species	Shade tolerance	Effective rotation ages	Site requirements
Big-tooth aspen	Very intolerant	50-70	High; best development on well-drained loamy sands/sandy loams
Quaking aspen	Very intolerant	40-50, 50-60	Low; best development on sandy and silt loams

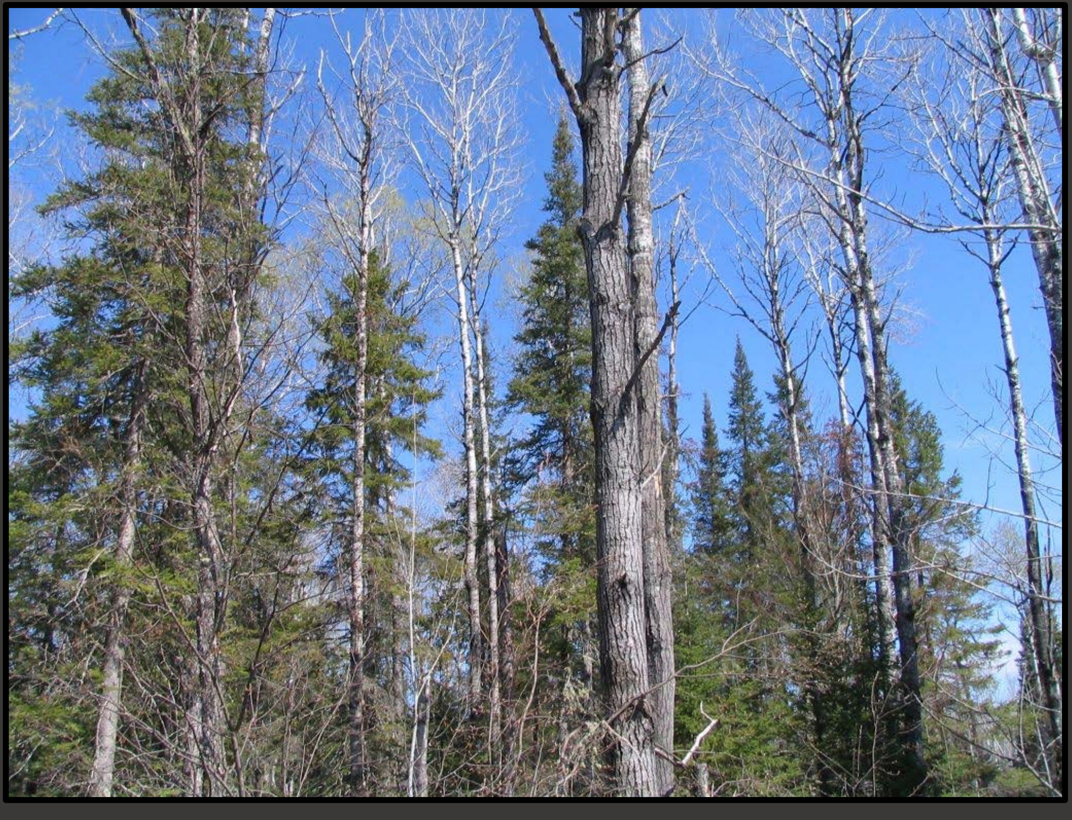
- Aspen requires disturbance across space and time to maintain dominance on a site
  - Large openings (> 1 acre)
  - Shorter rotations to maintain rootstocks
- Aspen dominance on a particular site does not always indicate it is a “good site” (i.e., SI $\geq$ 70 ft) to promote aspen for production

Aspen silvics

- Primary modes of reproduction
  - <u>Root suckers</u>
    - Arise from adventitious buds in roots
    - Stimulated by decrease in auxin from parent stem
    - Require warm (> 55°F), aerated soil conditions
    - Faster early growth than regeneration from seedling origin (inherit root system and carbohydrates from parent tree)

Aspen silvics

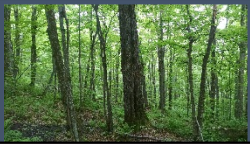
- Aspen begets aspen
  - If objectives involve naturally regenerating aspen-dominated stand, at least 10-20 ft^2/ac of overstory aspen is needed (~50 TPA across site)



Aspen silvics

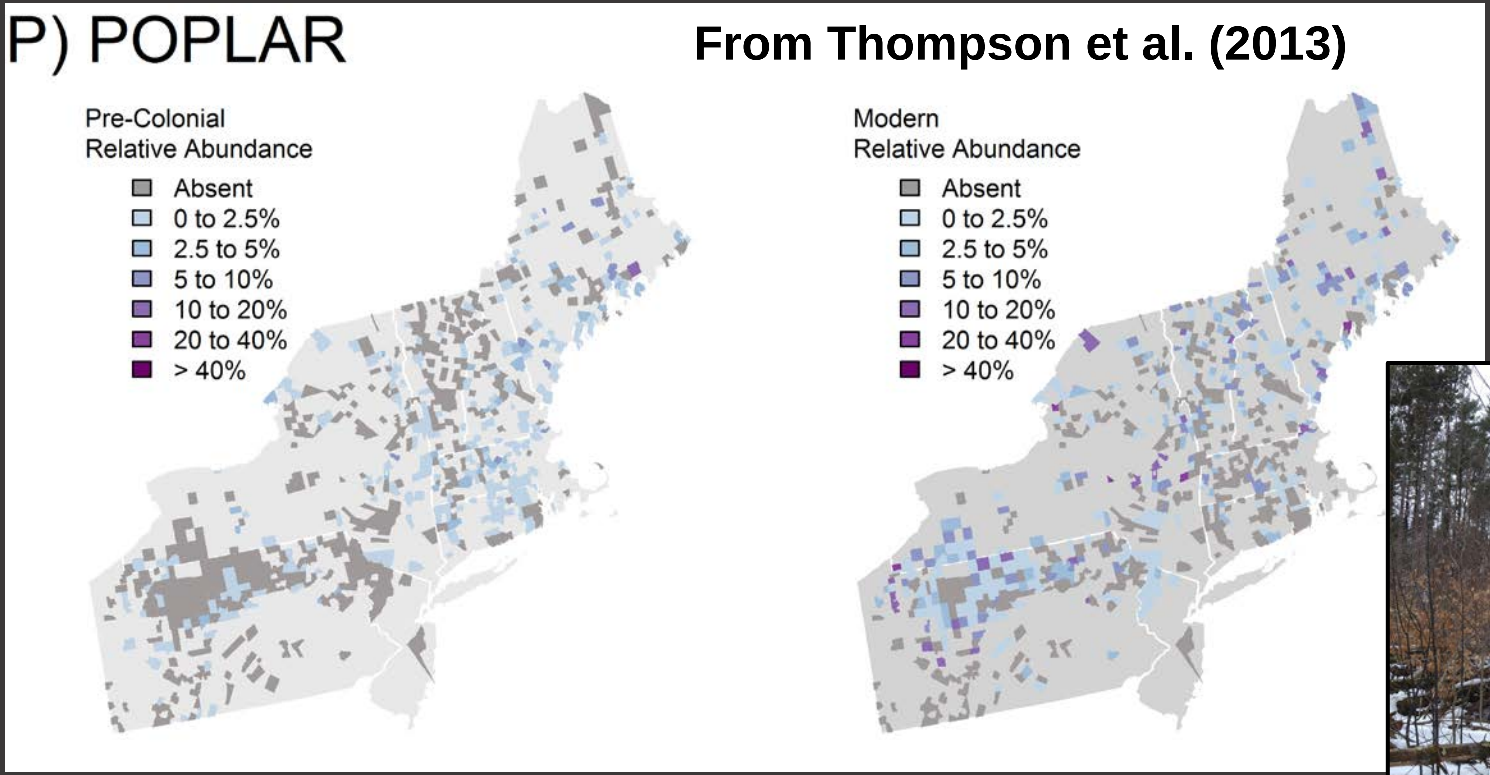
- Primary modes of reproduction
  - Wind-dispersed seed
    - Seed dispersal between May-June (often miles)
    - Good seed years every 4-5 years
    - Limited longevity (2-4 weeks)
    - Requires moist, mineral soil seedbed

Historic distribution of aspen



Historic distribution of aspen

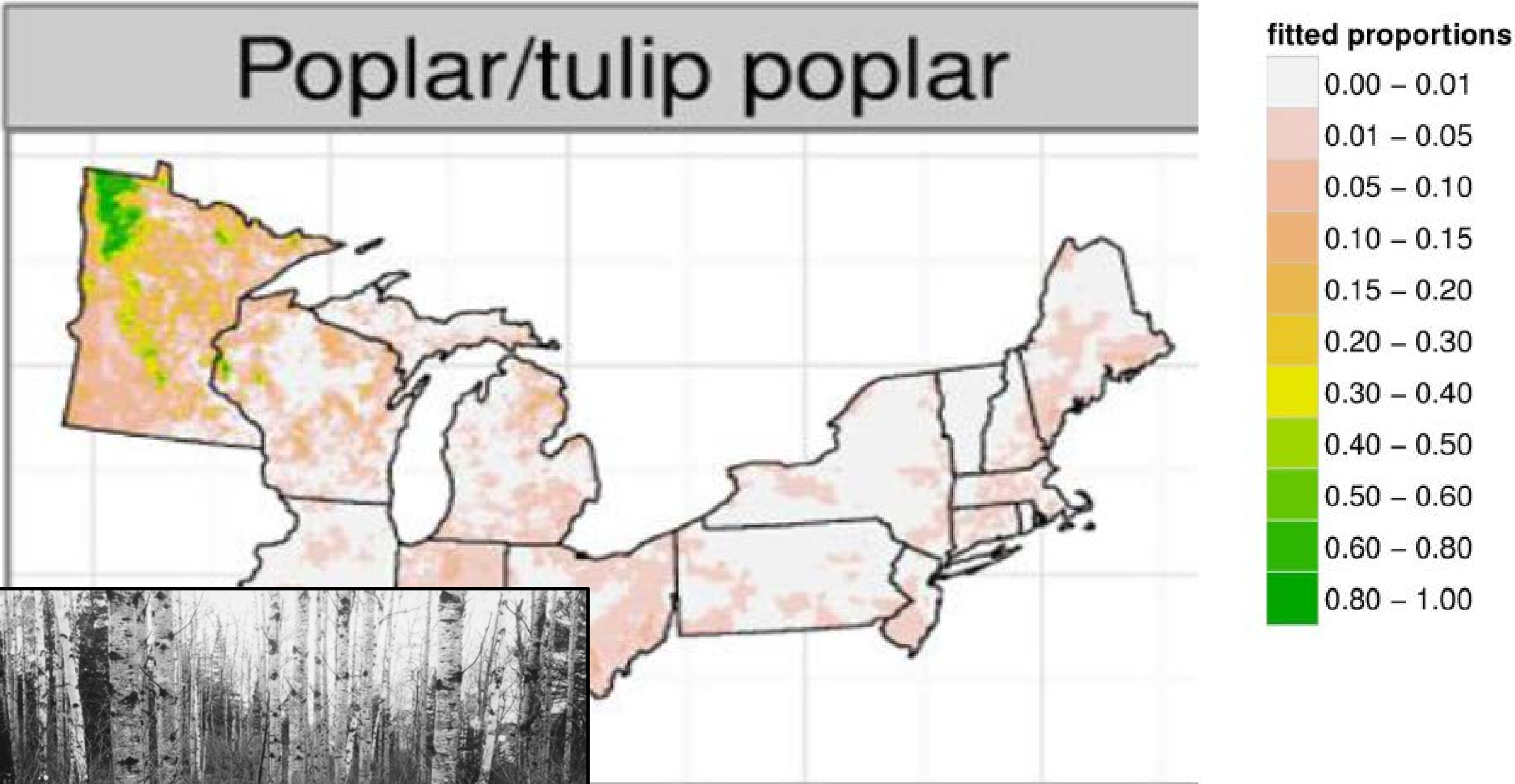
Northeastern US

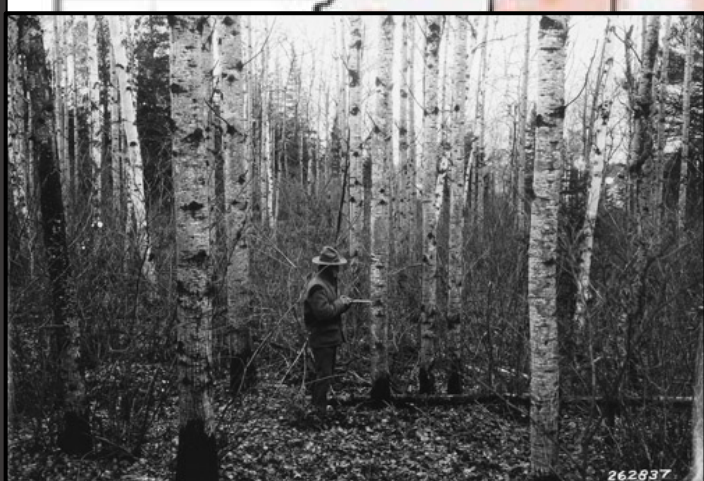


- Very minor component of historic and contemporary landscape
- Early successional stage for many dominant forest types in region (northern hardwoods, spruce-fir, oak-pine)

"Temporary" successional stage resulting from fire or windthrow (Westveld 1956)

Fitted map of % witness trees (virtually all "aspen" in northern tier) in presettlement surveys (PalEON data and Paciorek et al 2016).

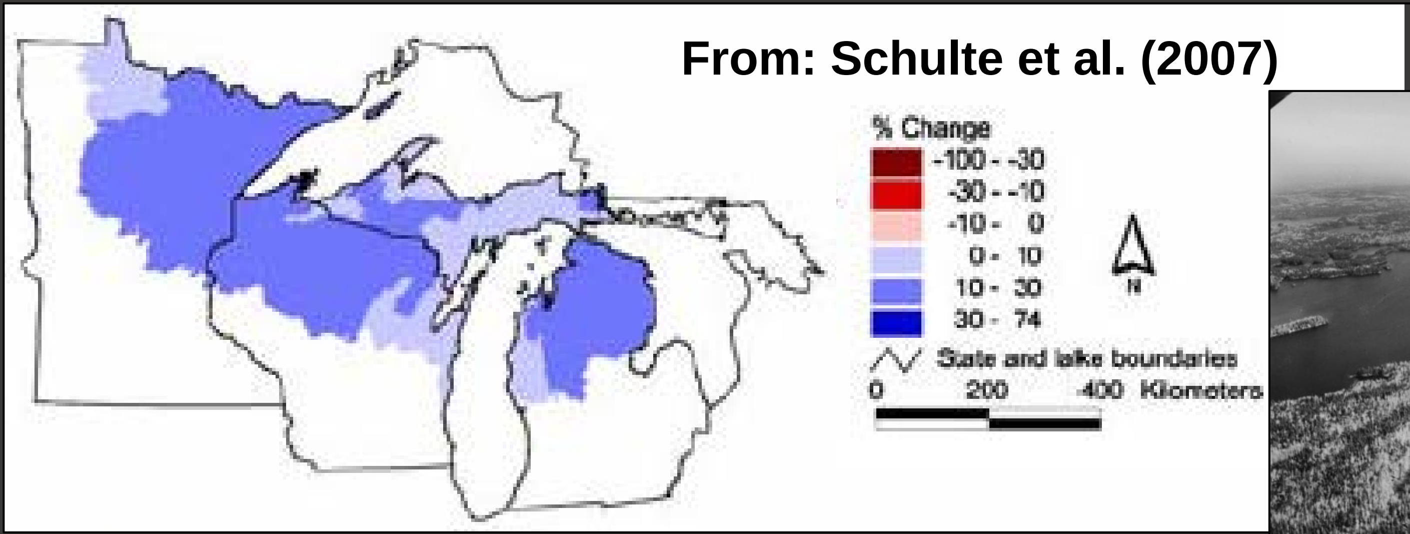




- Greater site-level dominance in western Lake States
- Existed most often as component of mixed species communities

Historic distribution of aspen

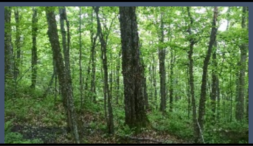
Change in aspen dominance from presettlement to present

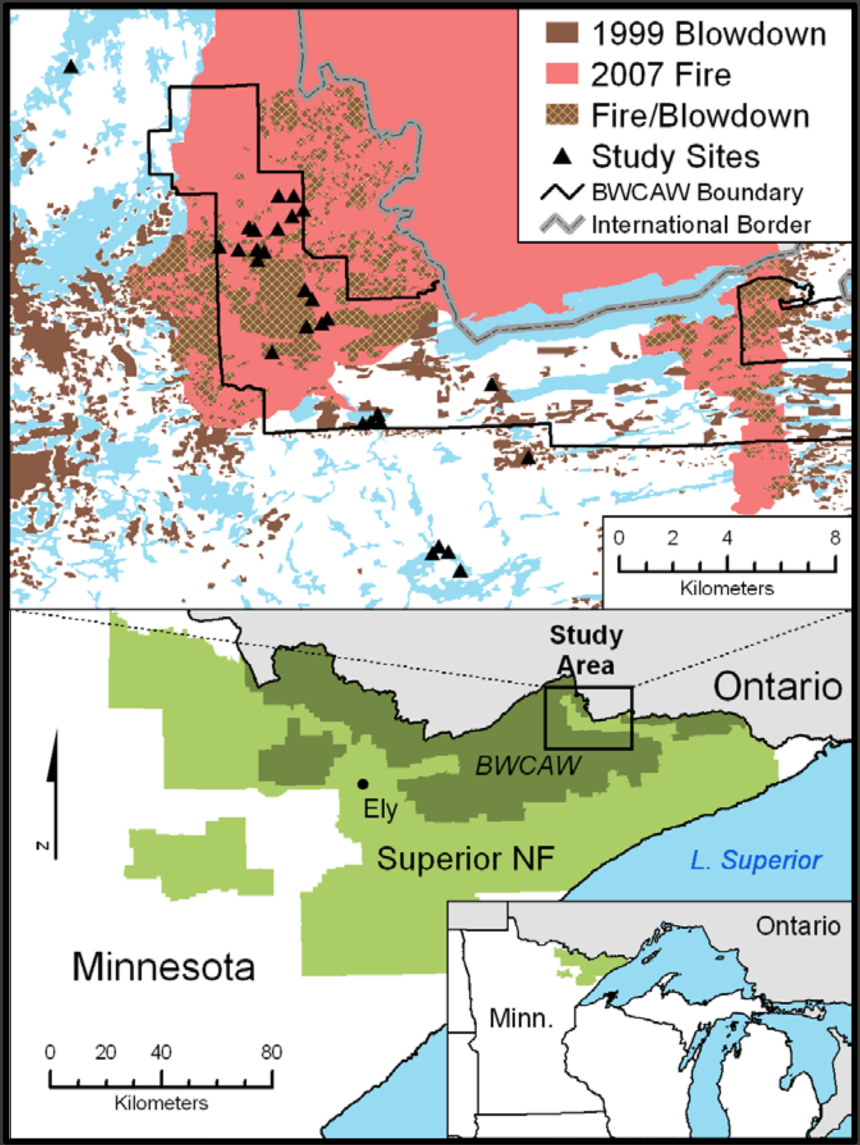


- Post-cutover rise in aspen dominance has been maintained through clearcut harvesting in many regions
- Regional homogeneity due to loss of conifer species and spatial complexity in distribution of aspen forests historically maintained by natural disturbance

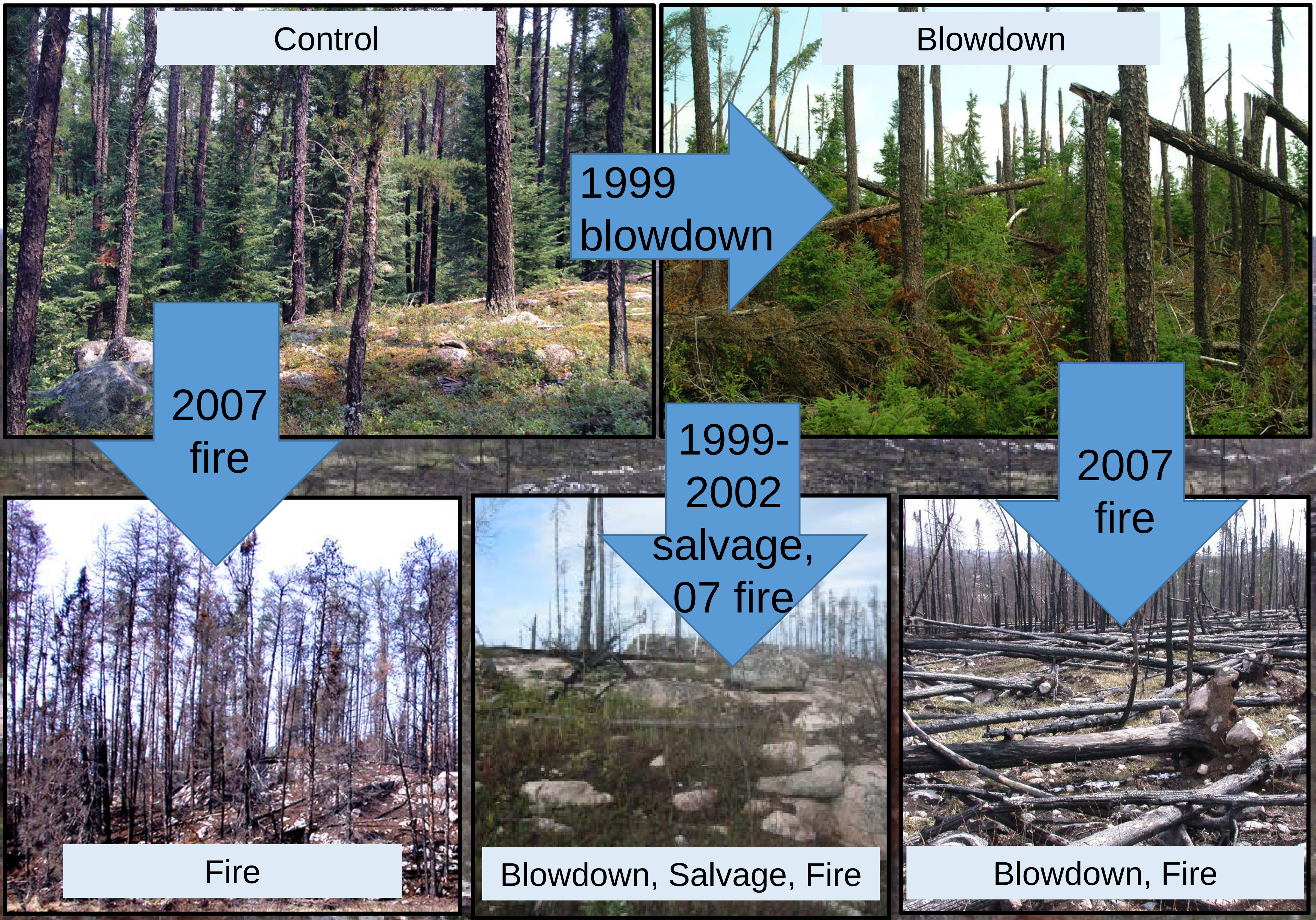
Aspen development across sites

Fire-dependent sub-boreal model



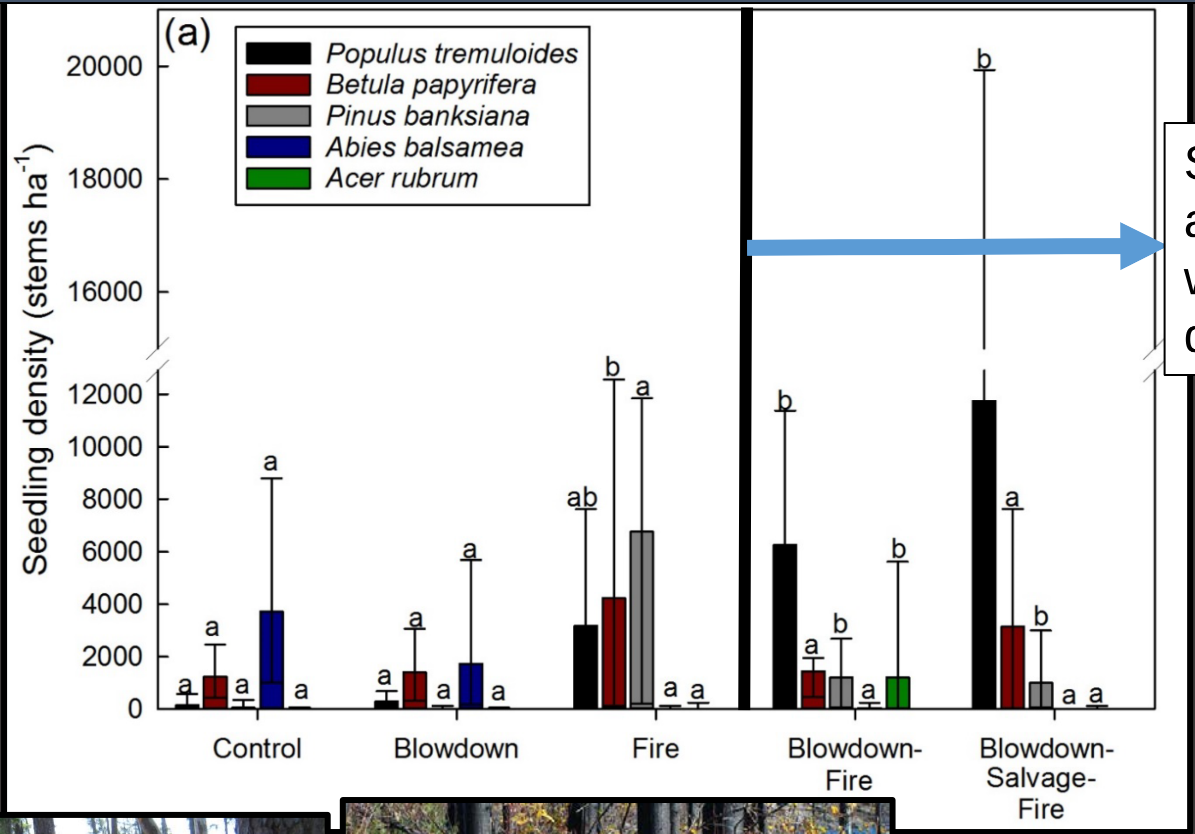


- Gunflint Trail Corridor, Superior NF, MN
- Dominated by mature jack pine stands (~65 yr) on shallow soils over Precambrian bedrock
- Sequence of disturbance events:
  - **1999:** derecho damages over 200,000 ha
  - **1999-2002:** Extensive salvage operations to reduce resulting fuel loads and risk
    - Frost/snow-free conditions
  - **2007:** Ham Lake fire burns 14,800 ha, including all salvaged sites



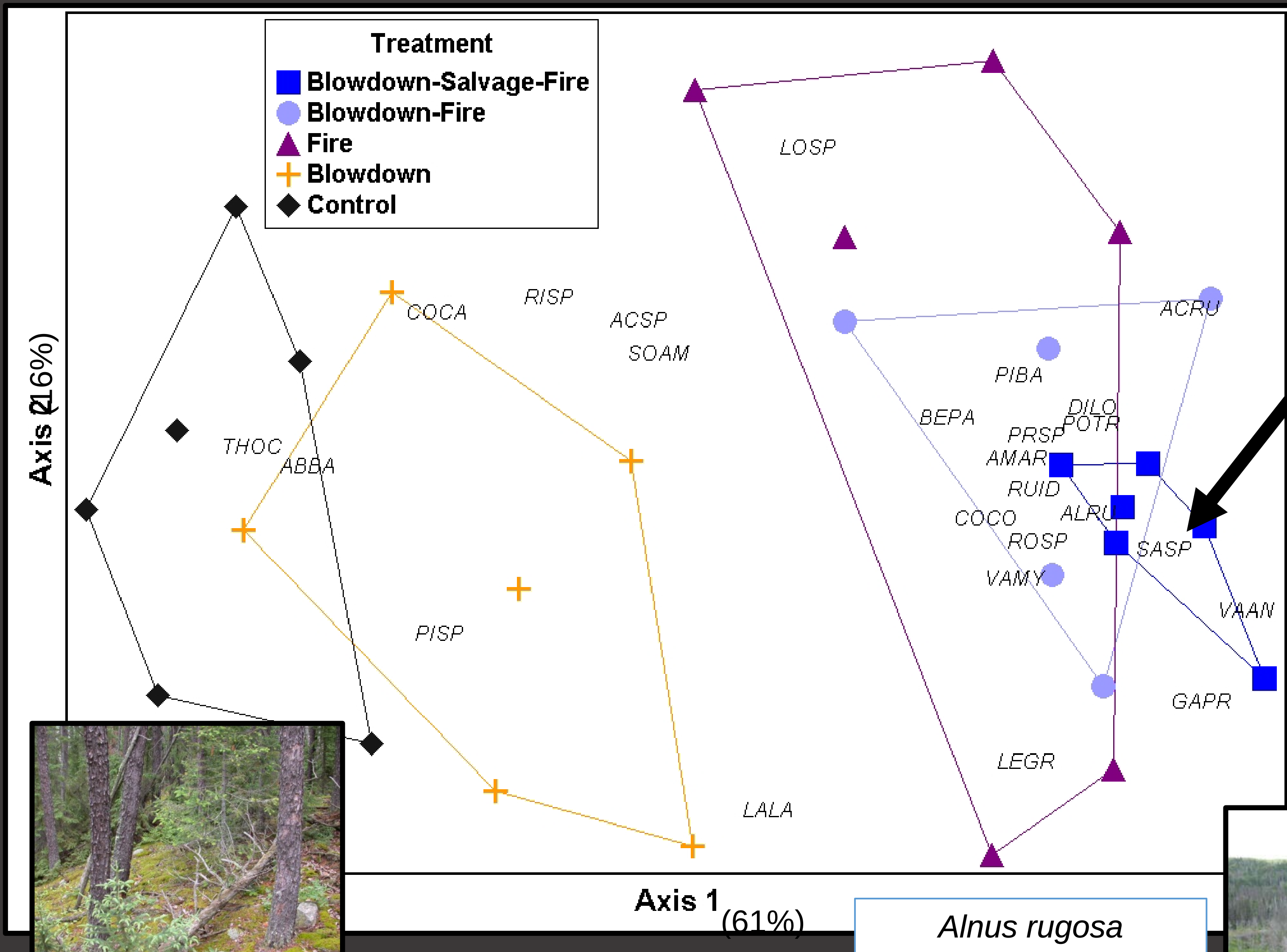
Sampled 6 study sites per disturbance condition in 2009

Fire-dependent sub-boreal model



D'Amato et al. (2011)

Shift towards aspen dominance with compound disturbance



Simplification of woody plant community and shift towards disturbance-adapted species

Abies balsamea
Picea mariana
Thuja occidentalis
Cornus canadensis

Alnus rugosa
Amelanchier arborea
Diervilla lonicera
Corylus cornuta
Populus tremuloides
Vaccinium myrtilloides

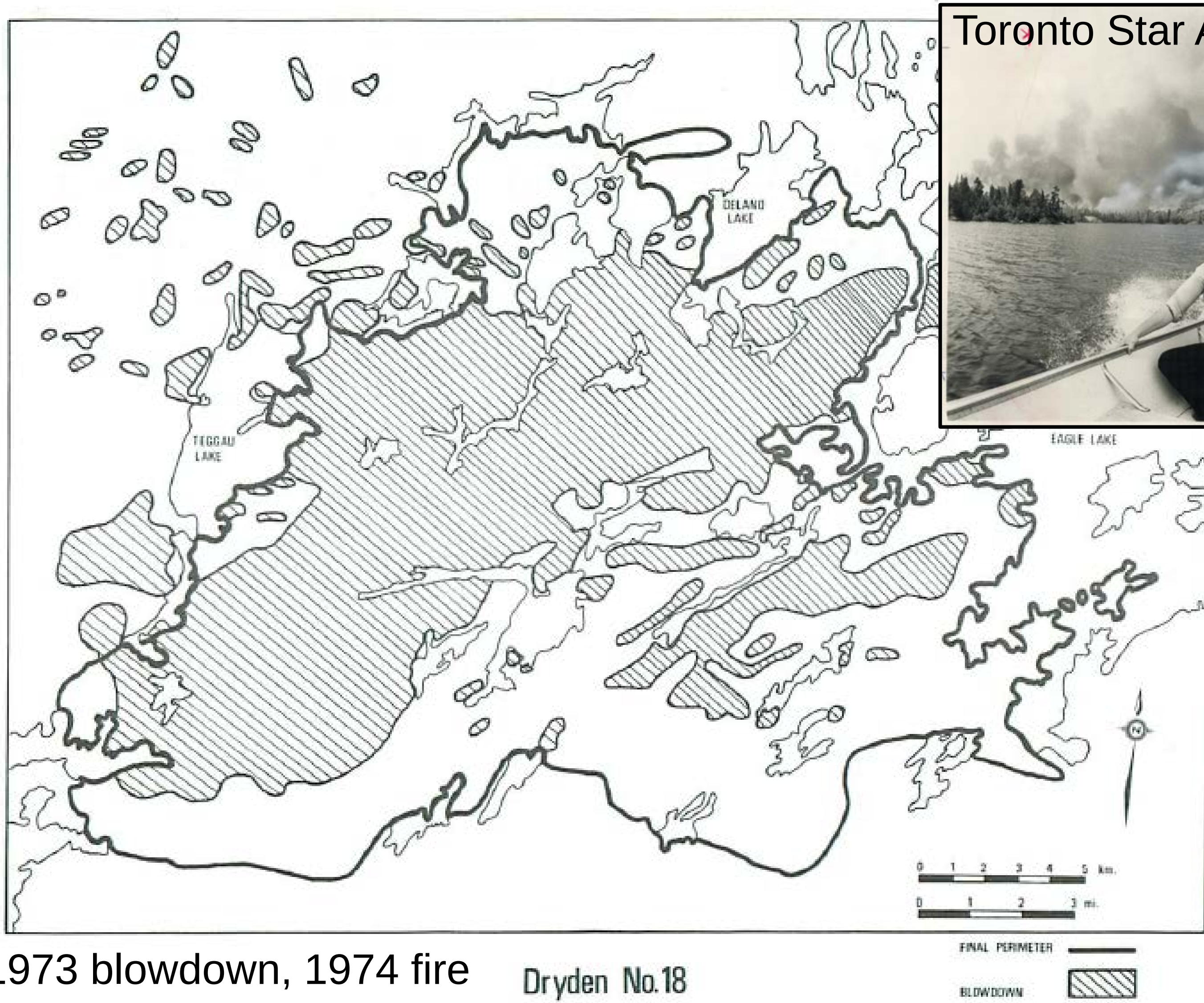
Disturbance effects on composition

Treatment	Species richness	Species diversity	Dissimilarity[§]
Blowdown-Salvage-Fire	16.17 (11, 19)[a]	2.2 (2.0, 2.3)[a]	0.46 (0.21, 0.71)[a]
Blowdown-Fire	15.80 (13, 20)[ab]	1.9 (1.2, 2.2)[a]	0.68 (0.63, 0.71)[b]
Fire	17.17 (15, 19)[a]	2.0 (1.7, 2.2)[a]	0.71 (0.46, 0.89)[b]
Blowdown	16.17 (10, 22)[a]	1.7 (0.9, 2.4)[a]	0.69 (0.56, 0.83)[c]
Control	10.50 (8, 16)[b]	1.7 (1.1, 1.9)[a]	0.63 (0.25, 0.88)[c]

Compounding of disturbance effects at stand-scale via salvage logging reduced microhabitat heterogeneity and homogenized plant community composition

§ Sørensen's index of dissimilarity

Fire-dependent sub-boreal model



1973 blowdown, 1974 fire

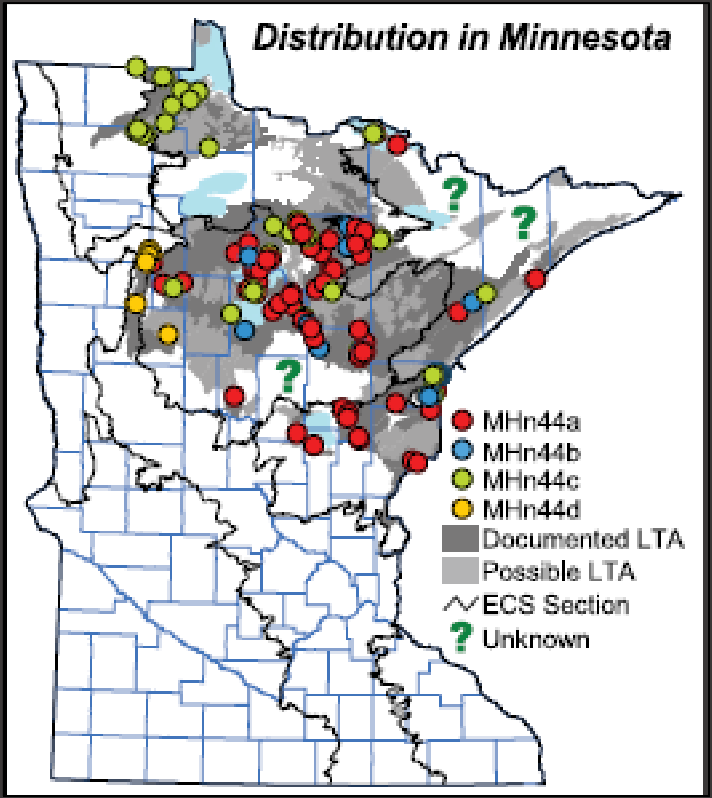
Fig. 6(b). Blowdown within perimeter of Dryden fire No. 18.

Toronto Star Archives

Blowdown-Fire dynamic has recent and historic precedent

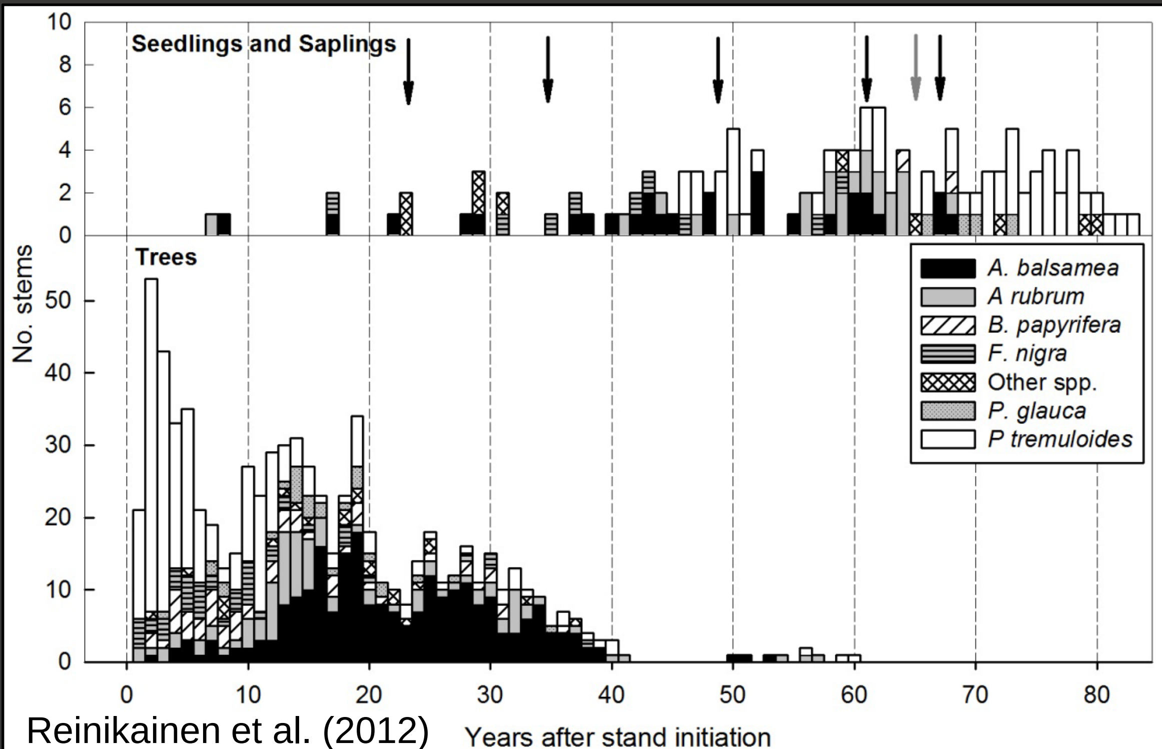
Wet-mesic developmental model

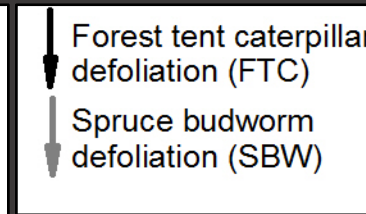
Northern wet-mesic boreal hardwood conifer forest (MHn44)



- Most common aspen-dominated forest type in MN
- Glacial lake deposits, stagnation moraines, and till plains
- High local water table (~460 year rotation for stand-replacing fire; MN DNR 2003)

Wet-mesic developmental model

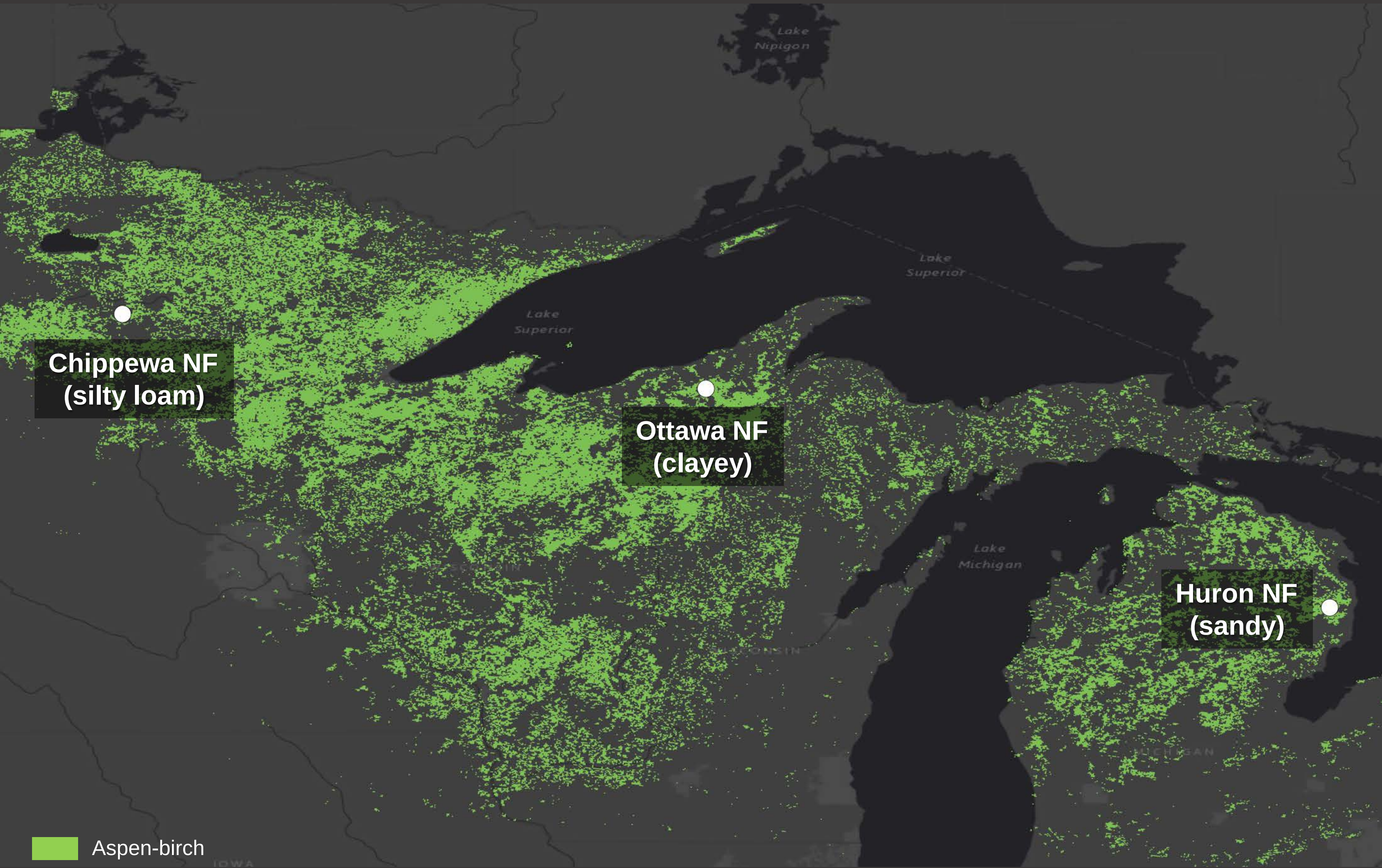




- Chronic defoliation events from forest tent caterpillar represent important driver of complex mixed-species, multi-cohort aspen stands on mesic sites
  - Even-aged aspen monoculture is land use legacy
- Consistent with work in western Canada highlighting variability in aspen age structures beyond single-cohort model

Management response across sites

Long-term Soil Productivity Study



Long-term Soil Productivity Study

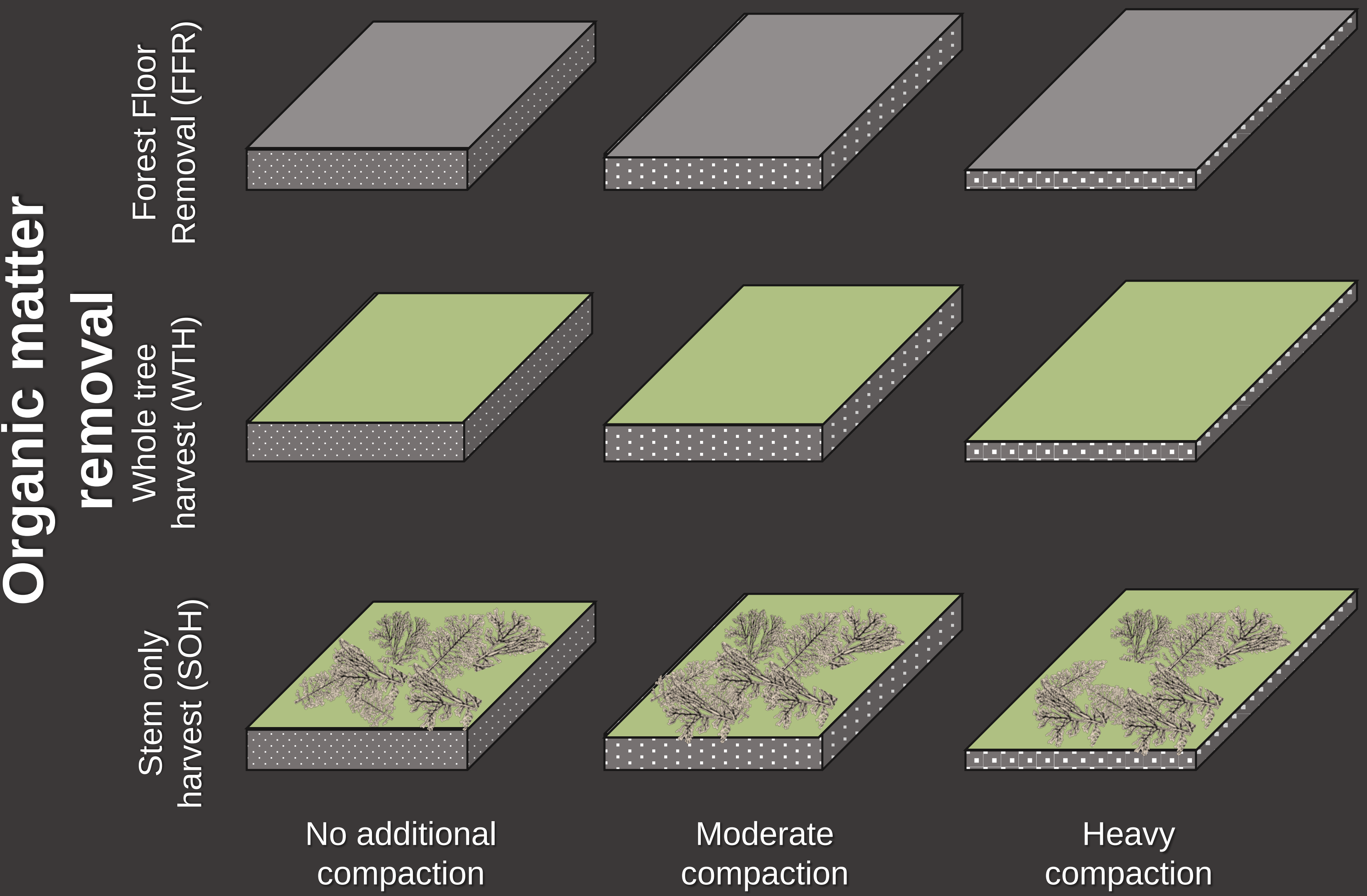
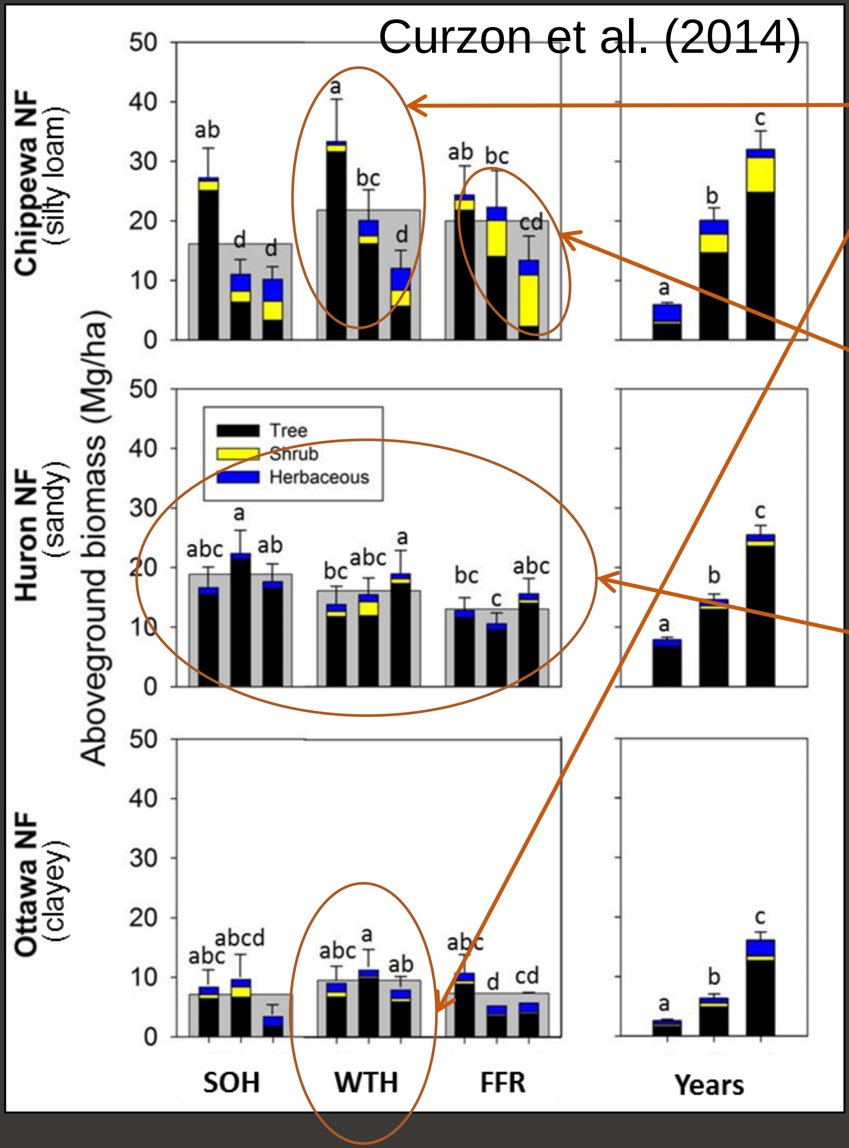


Photo credit: USFS 1994

Long-term Soil Productivity Study

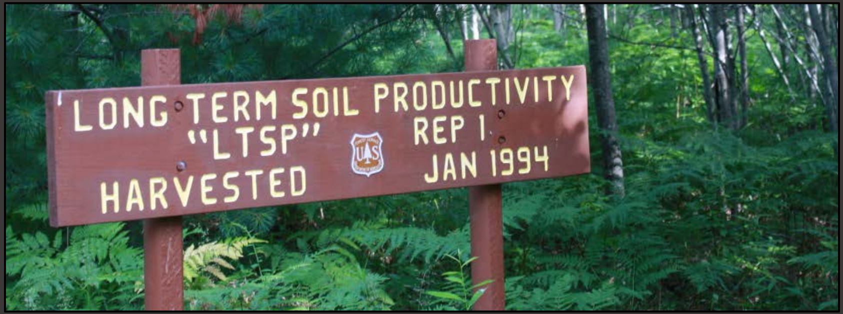
Treatment impacts on aboveground biomass after 15 years



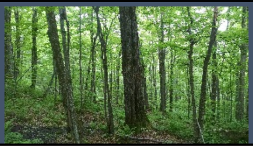
Removing residues **did not** reduce above-ground biomass on silty loam or clayey soils

The most severe disturbance treatments led to greater shrub biomass on silty loam soils.

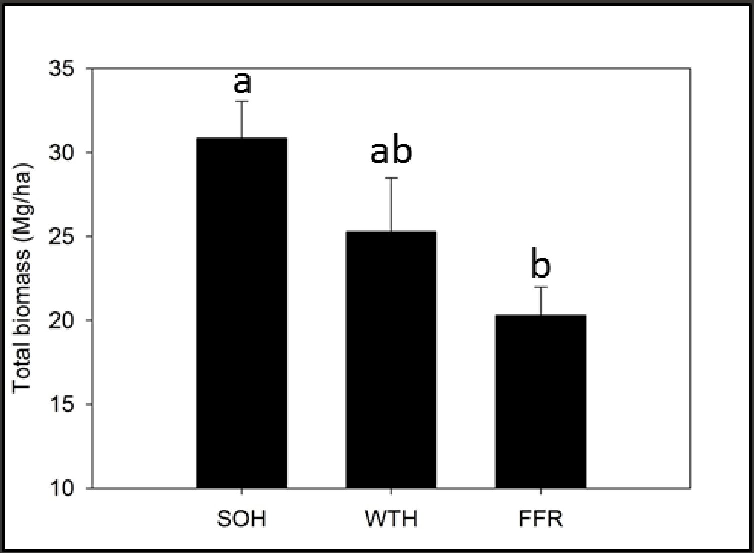
Removing residues **did** reduce above-ground biomass on sandy soils.



Long-term Soil Productivity Study



Treatment impacts on tree biomass after 15 years

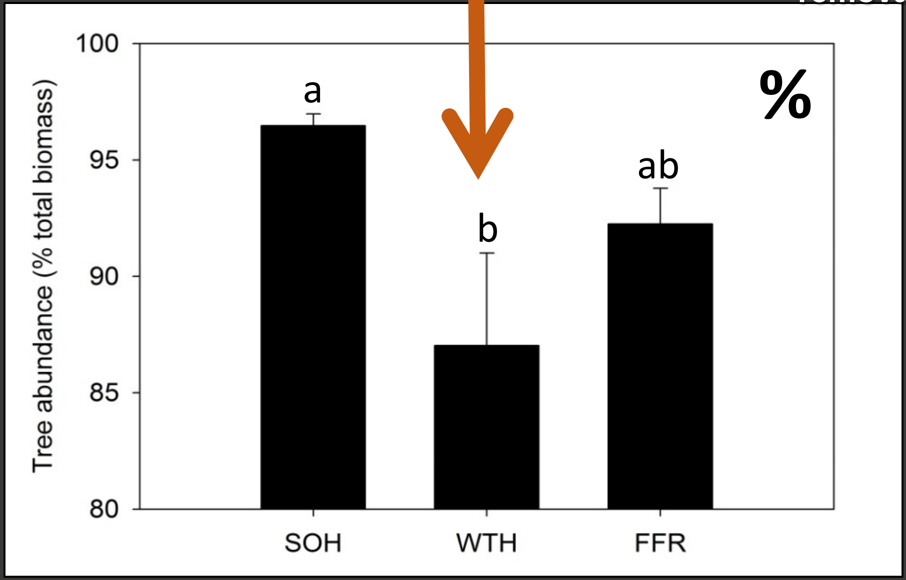


Stem-only harvest

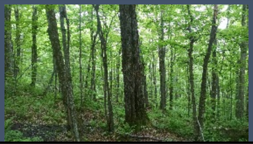
Whole-tree harvest

WTH + Forest floor removal

- Whole-tree harvest disproportionately reduced <u>tree</u> biomass 15 years post-harvest on sandy soils.
  - Lower stem densities and smaller diameters



Management response across sites



- Multiple developmental pathways and ecological conditions following disturbances, including fire, often ignored
- Aspen productivity on fire-dependent sites most sensitive to harvest impacts
  - Restoration of fire to achieve ecological objectives and encourage other historically common associates (e.g., jack pine)

Integrating disturbance legacies

Integrating disturbance legacies

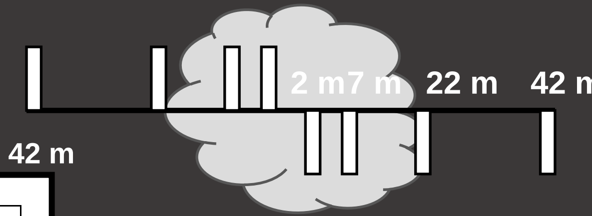
- Importance of structural retention for biodiversity objectives widely recognized (and enforced)
- Aspen silvics present challenge in relation to retention due to intolerance and auxin regulation of sprouting
  - Retention of 10-15 ft^2/ac has been shown to reduce sucker height growth and densities by 40-50%

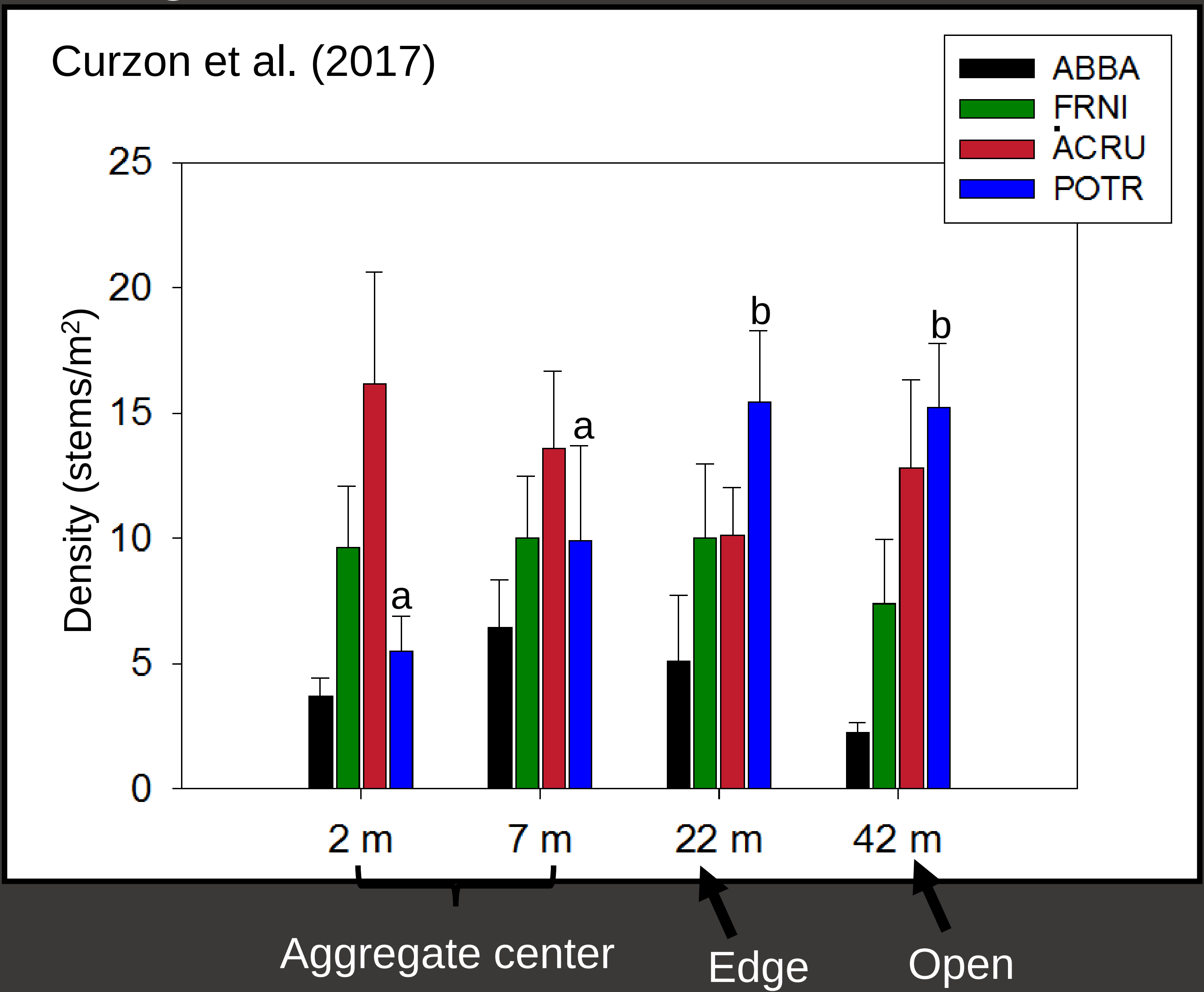
Integrating disturbance legacies

- Application of aggregate reserve patches minimizes influence of residuals and maintains other species options on site

Integrating disturbance legacies

- Effects of aggregates on tree regeneration





Conclusions

- General homogeneity of current aspen resource and its management masks historic complexity of these systems
- Simplicity of silviculture has provided important, reliable timber base for region, but often ignores range of development patterns for these forests
- Integration of structural legacies and broad compositional conditions historically characterizing these systems is critical for sustaining biodiversity and long-term resilience

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