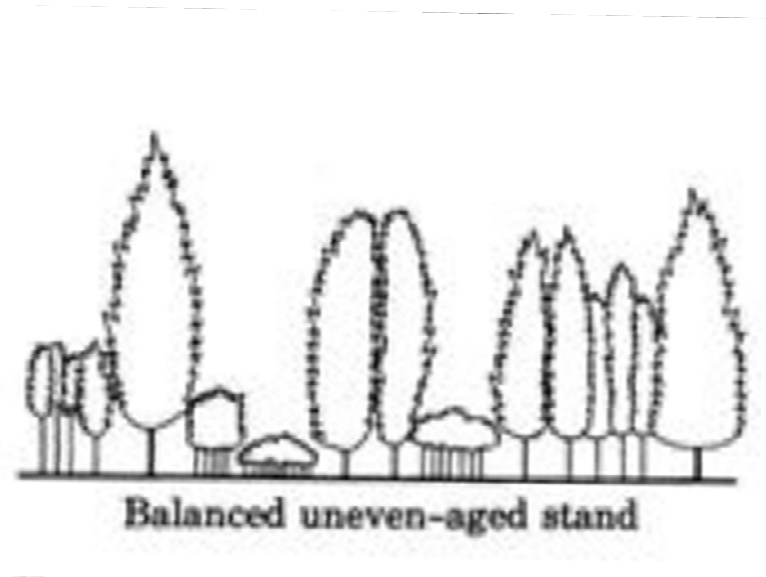
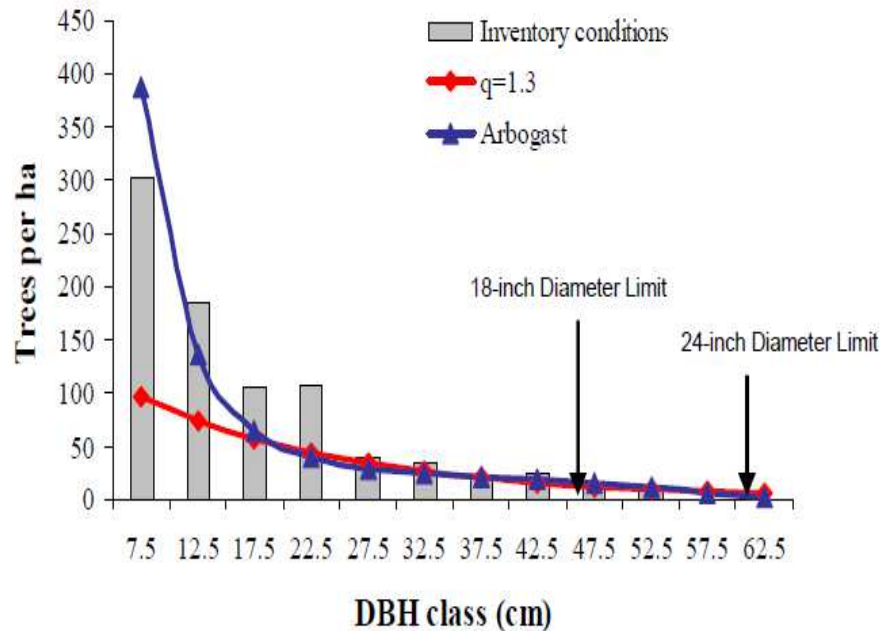


**Northern hardwood regeneration
dynamics in stands with an ash
component (or) When and why ash
wins**

Management of northern hardwoods

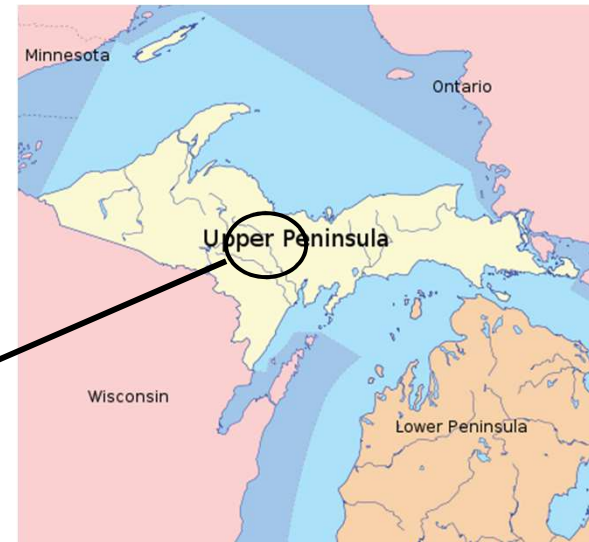
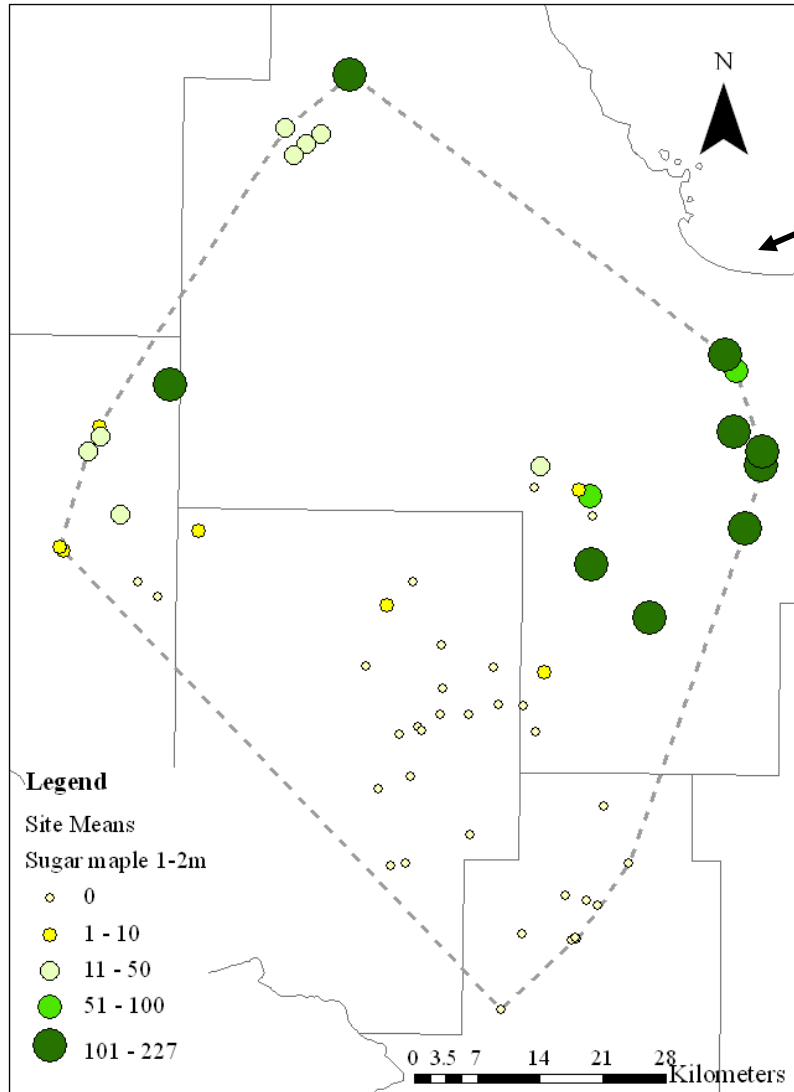


Uneven-aged: Every 10-20 years, harvest 1/5 to 1/3 of stand basal area. Tree removed from full range of size classes to extract valuable timber, improve residual stand structure and achieve a residual diameter distribution that assures long-term sustainability. Trees removed singly (single tree selection) or in groups (group selection)

Major assumptions

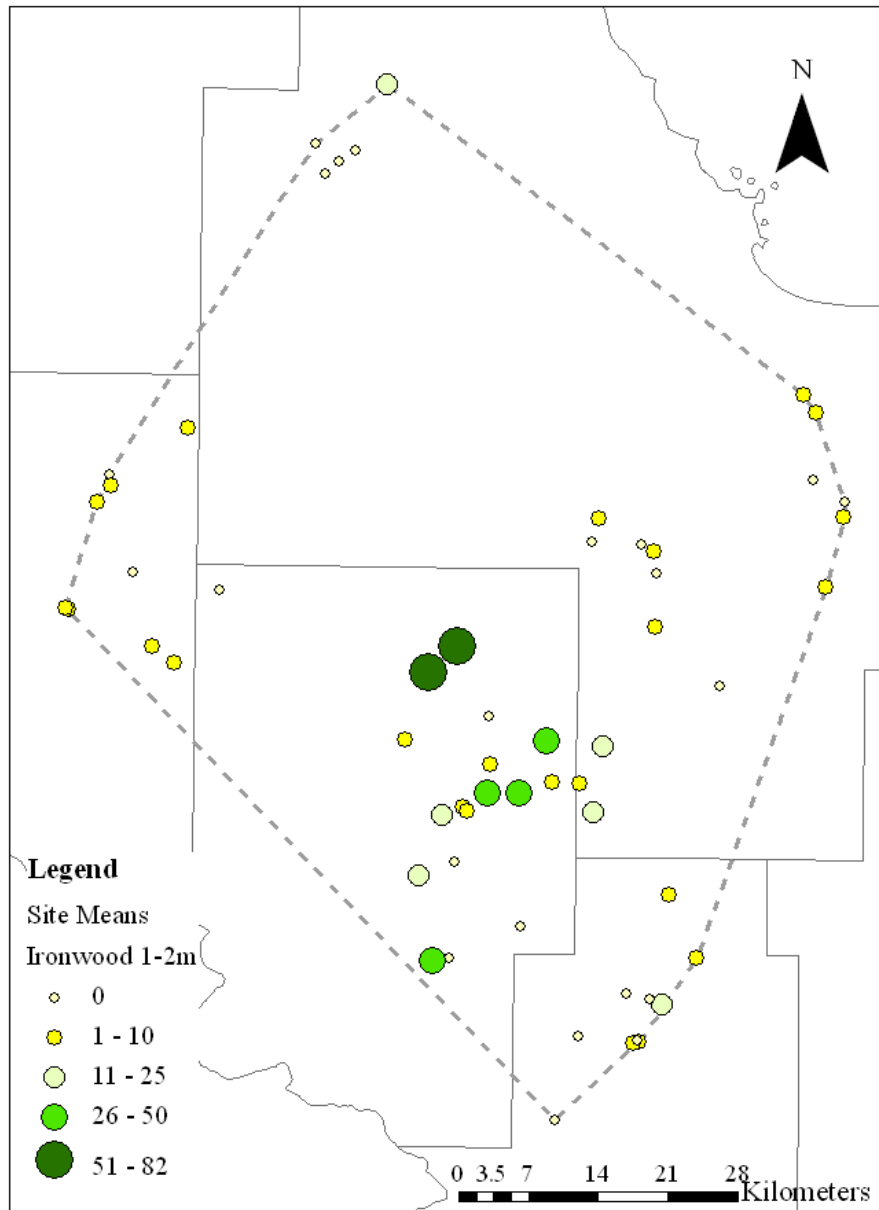
- Regeneration will be abundant and of desirable species.... Main target is sugar maple regeneration.
- Important that assumption is true because regeneration = sustainability

Patterns of regeneration in some areas suggest long-term sustainability is threatened



347 gaps distributed over 59 harvested gaps

No sugar maple sapling recruits in 50% Of gaps

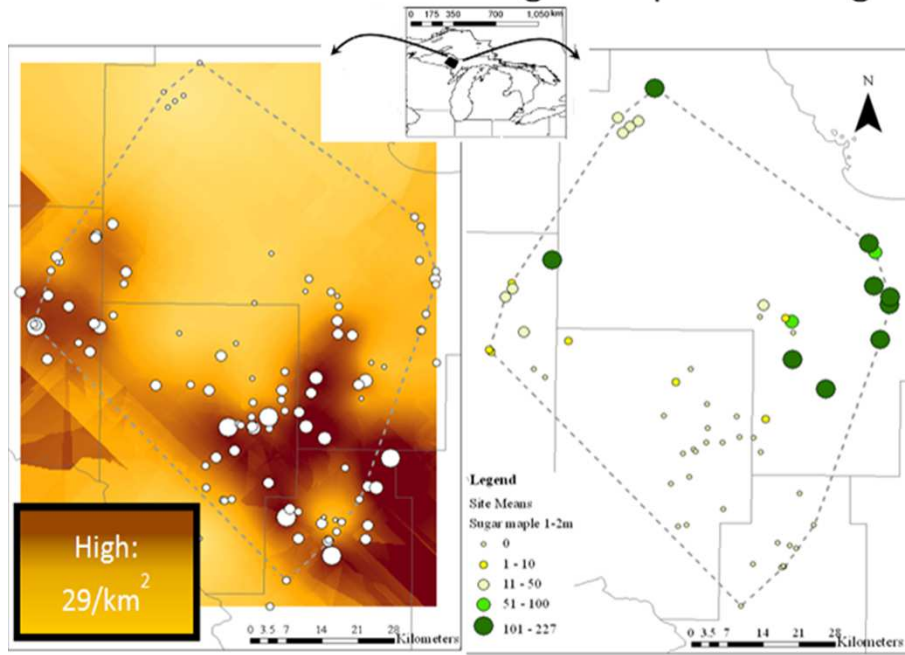


Gaps instead occupied by other species, mostly ironwood, or nothing at all

12% of gaps were empty

Winter deer

Sugar maple seedlings



Possible reasons for low sugar maple regeneration density

- Harvest gaps too small.
- Too many deer.
- Competing vegetation

Possible reasons for high ironwood regeneration density

- High local density of ironwood seed sources
- Too many deer

Possible reasons for low overall tree diversity

- Harvest gaps too small
- Competing vegetation
- Missing seed sources?
- Seedling establishment substrates are limited?

Decreasing deer numbers may be
politically untenable

- But, might be able to change silviculture

Even-aged techniques



The shelterwood silvicultural system might help overcome regeneration limitations:

Unwanted species could be decreased by weeding them in a preparatory cut, maple and rarer, desirable species and could be favored for retention in a seed cut. Dense seedling numbers (hopefully) could be then be released

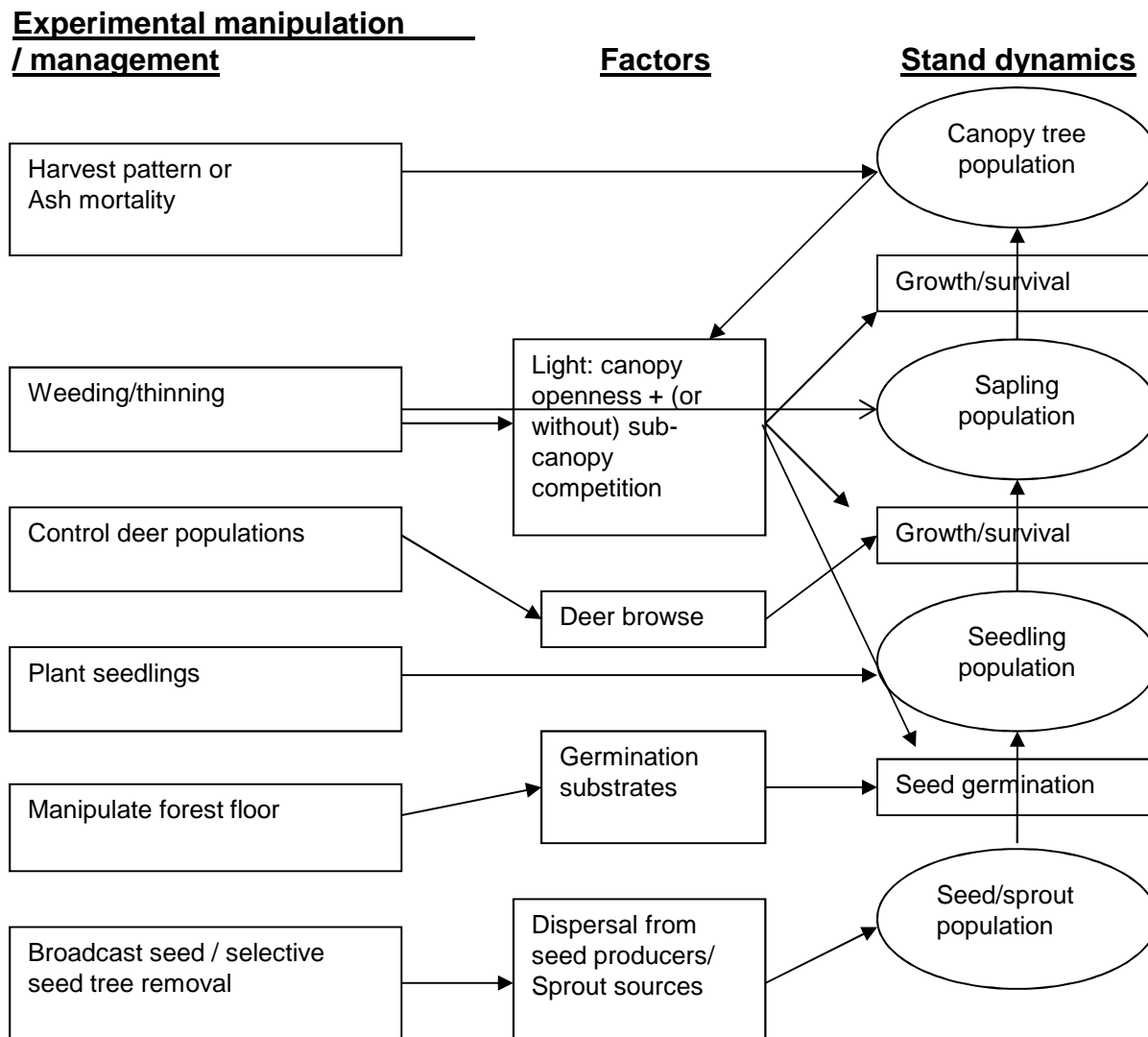
Uneven-aged: Group selection and/or variable gap size approach

Diameter	Area (acres)	Considerations
25	0.011	Minimum gap size capable of facilitating recruitment of most shade tolerant species
30-40	0.016-0.029	Typical crown area of 18-26" sugar maple, Recommended standard gap size for single tree selection
50-60	0.045-0.065	Recommended minimum gap size for canopy recruitment of mid-tolerant species
75	0.101	Maximum crown area of largest beech trees. Largest gap size for single tree selection. Common size for small group selection. Gaps 50 to 75 feet wide may be necessary to encourage red oak and black cherry. May need site preparation and/or control of undesirable regeneration
167	0.503	Maximum for group selection. Minimum for even-aged systems.

Established harvest gap experiment
aimed at identifying:

- 1) What combination of factors cause poor regeneration patterns?
- 2) What can we do to overcome negative impacts on regeneration, including increasing diversity?
- 3) Are there special challenges in forests with ash and beech components?

Conceptual approach to identifying regeneration bottlenecks: several factors may contribute to low regeneration success

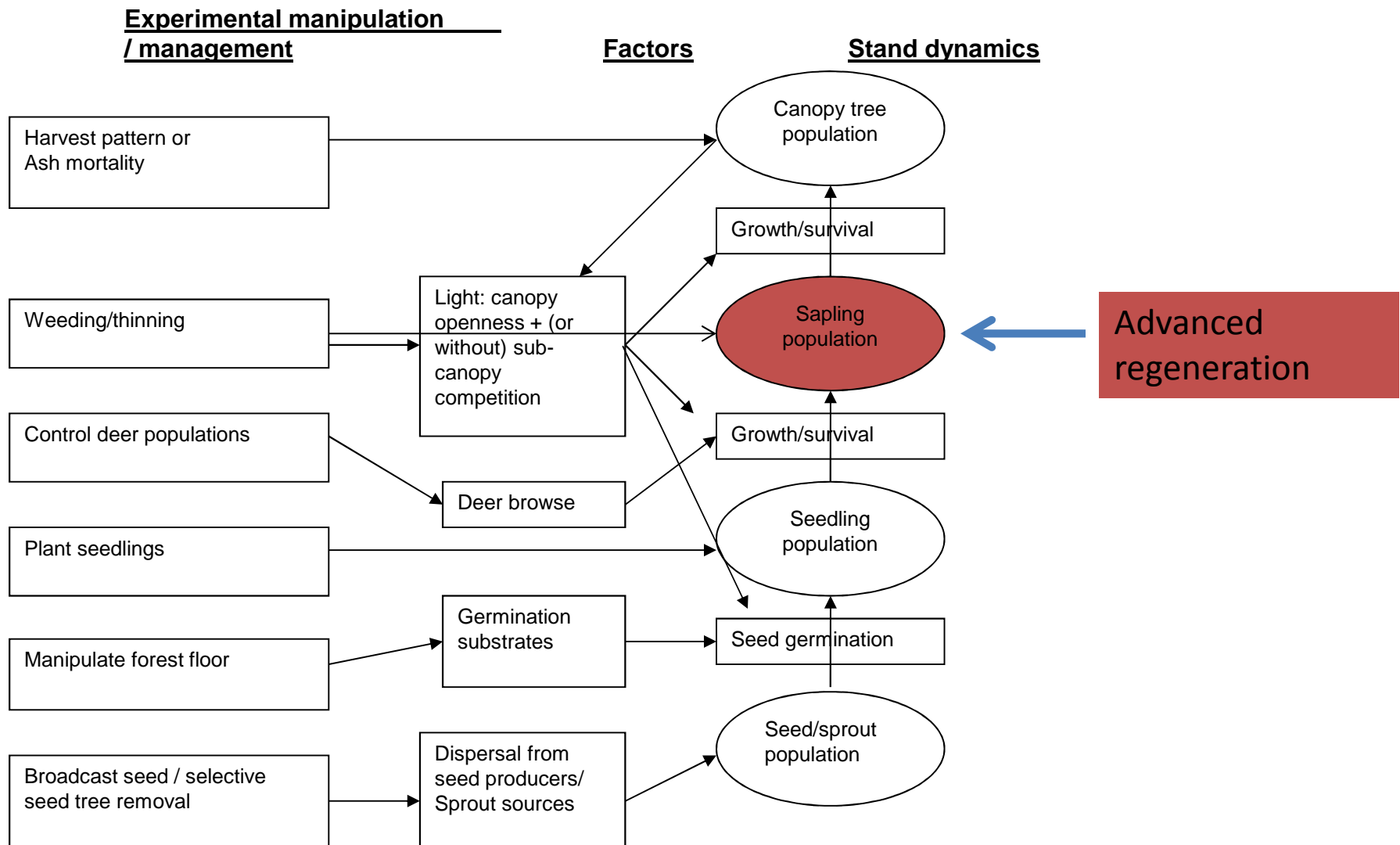


Two 40 acre installations: 45
harvest gaps in each: 2014, 8th
year private site, 5th year DNR site.

- At both sites : Effects of gap size and deer on planted and naturally established seedlings
- Private site only: removing vs. not removing advanced regeneration
- DNR site only: scarification and competing vegetation effects on planted seedlings

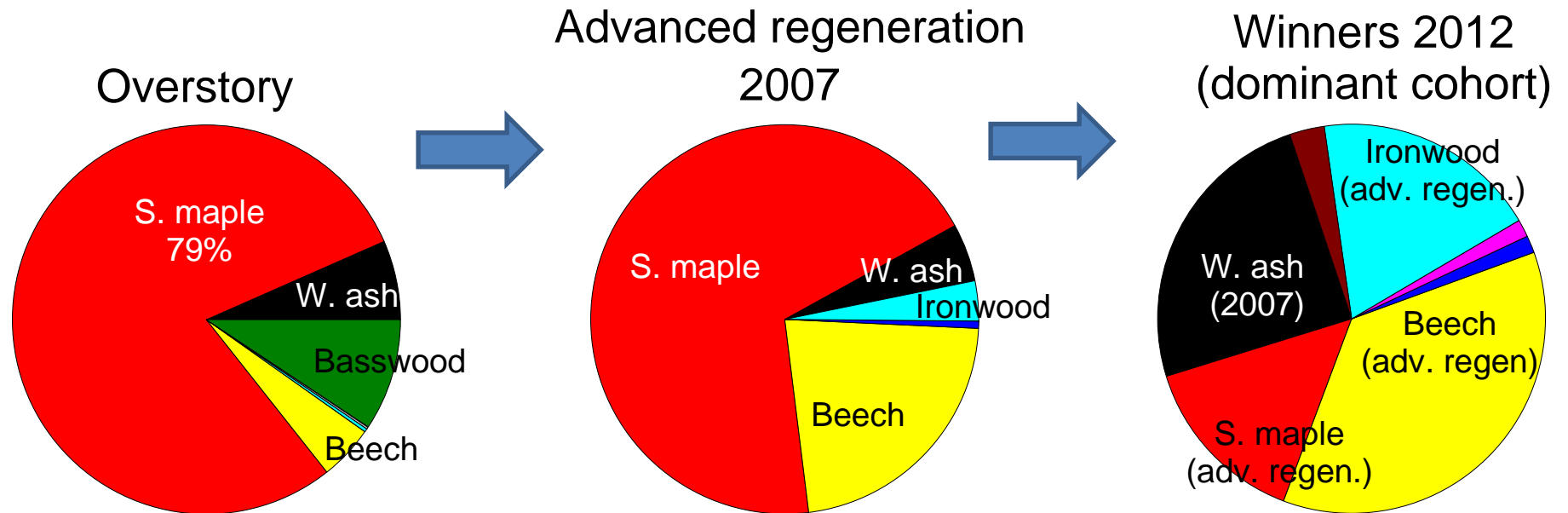


Conceptual approach to identifying regeneration bottlenecks



Naturally established seedlings

Advanced regeneration not removed

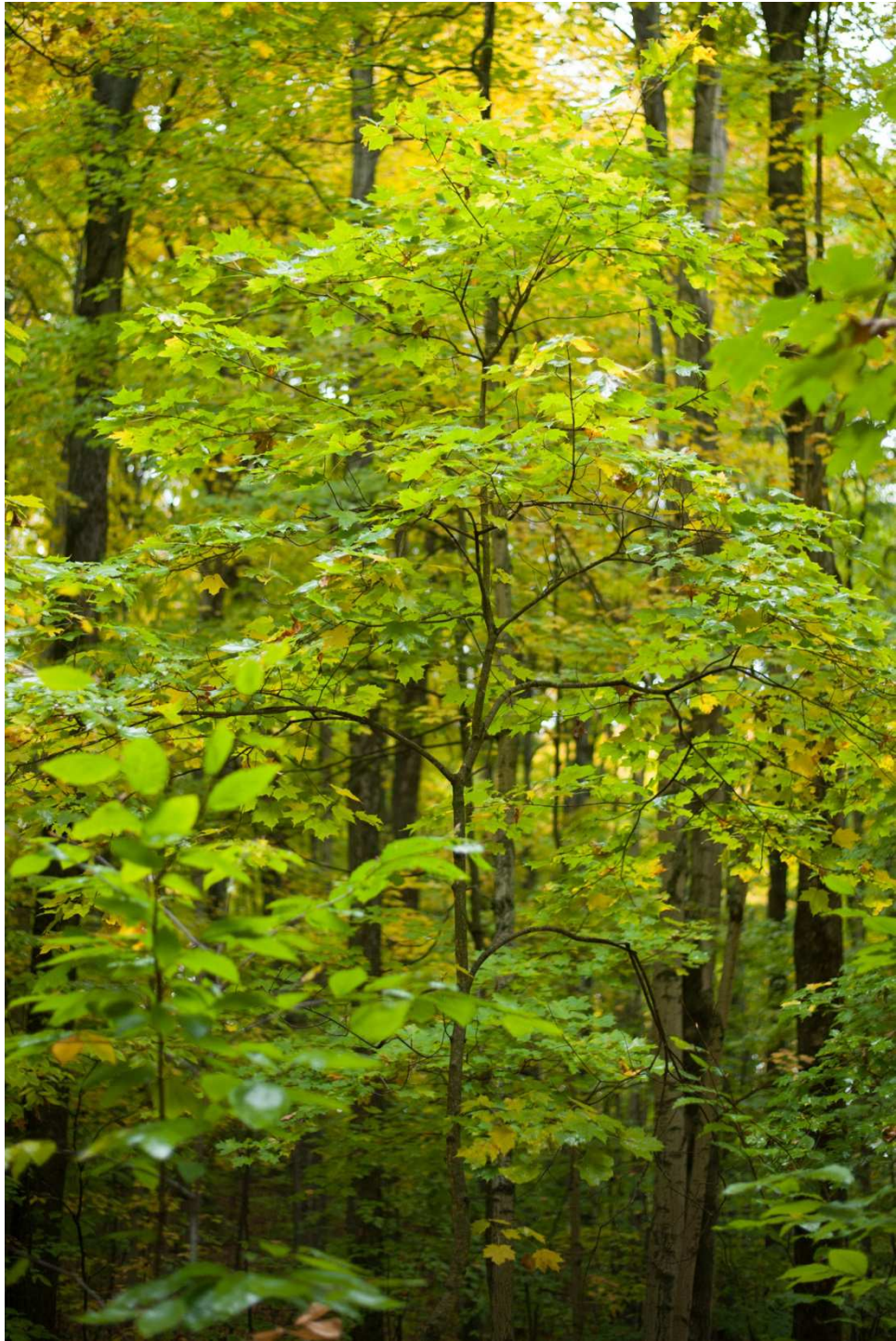


- Winners are disproportionately ironwood, beech, and ash. Why? Most sugar maple advanced regeneration is short.

- >95% of overstory and gap winners are four species, two of which are catastrophically impacted by introduced epidemics and another with little commercial values.

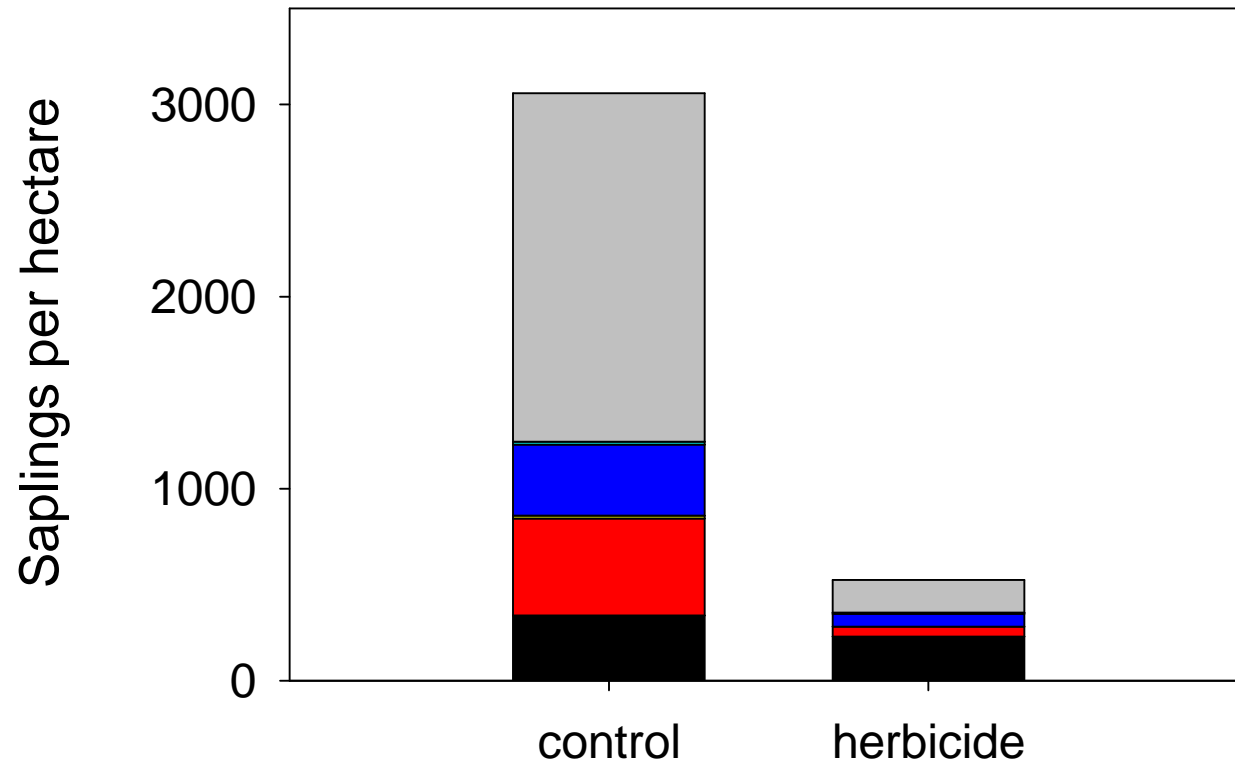
- Large advanced regeneration dominates winners. What you see is what you get.

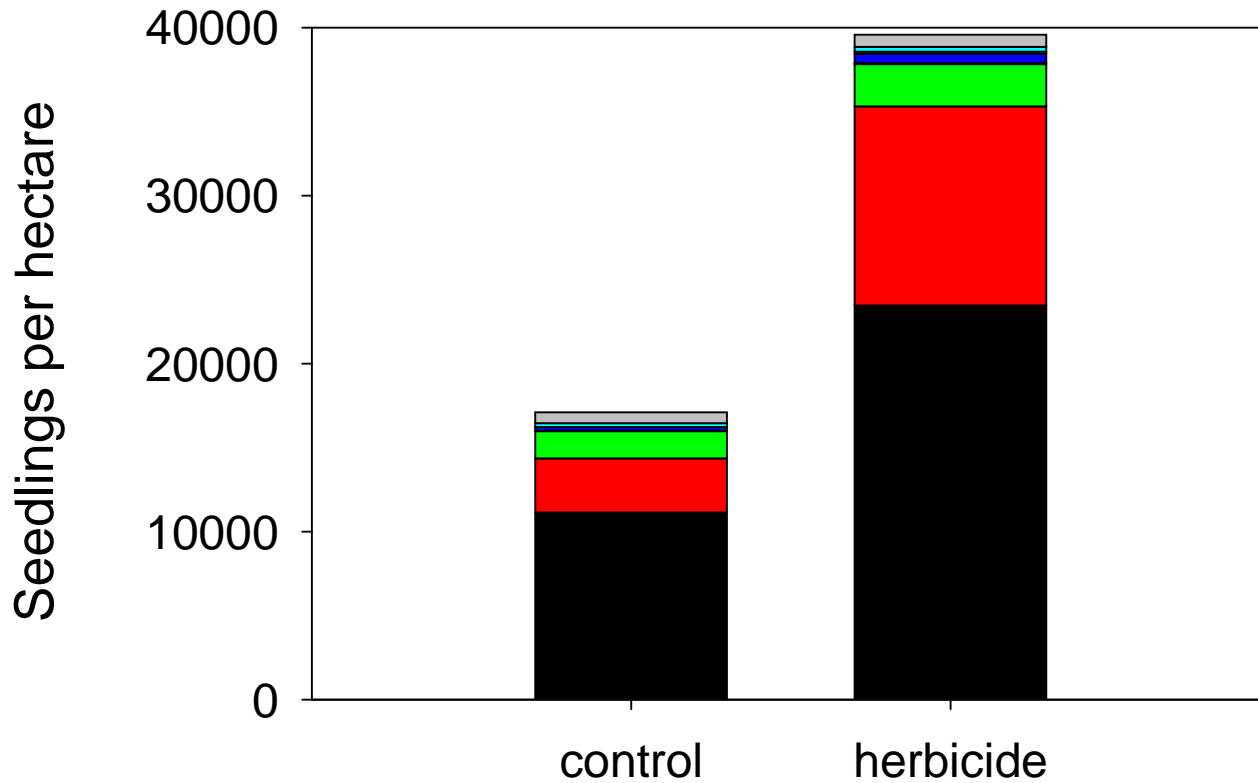






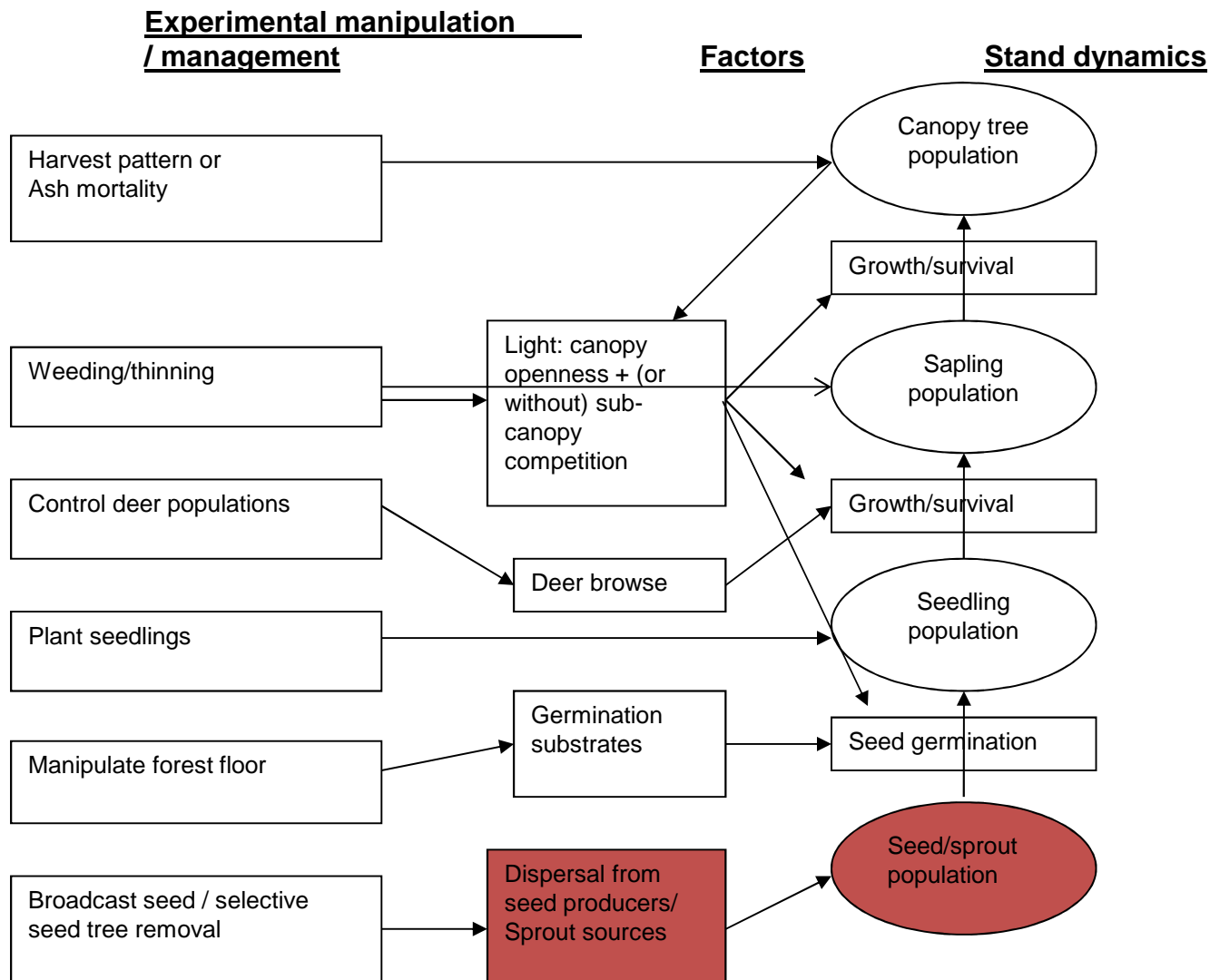
2014:after 8 years, the border between sapling herbicide treatment and control still clear

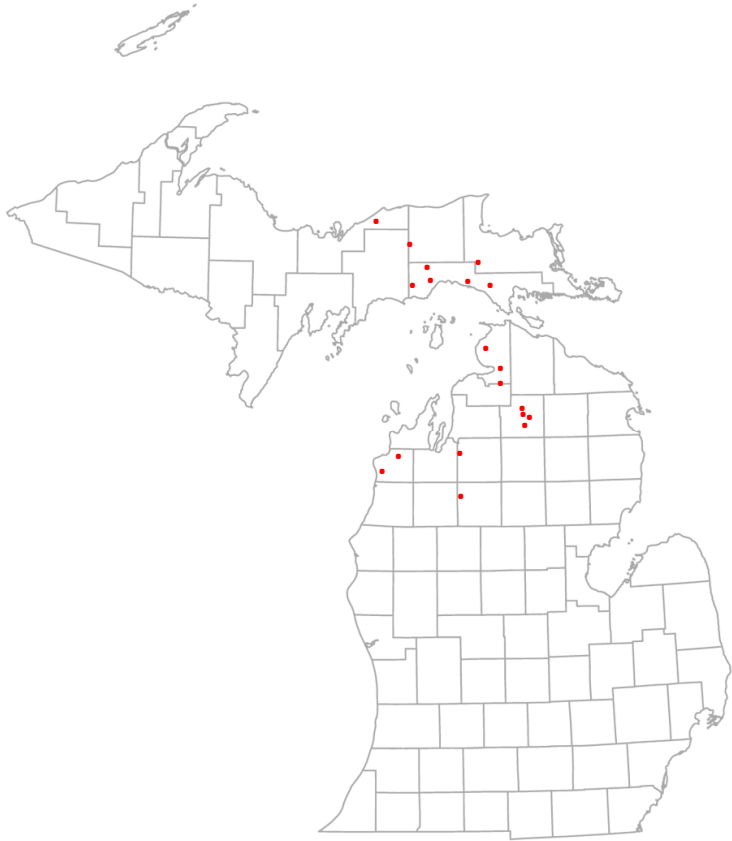




Be careful
what you wish for!

Conceptual approach to identifying regeneration bottlenecks

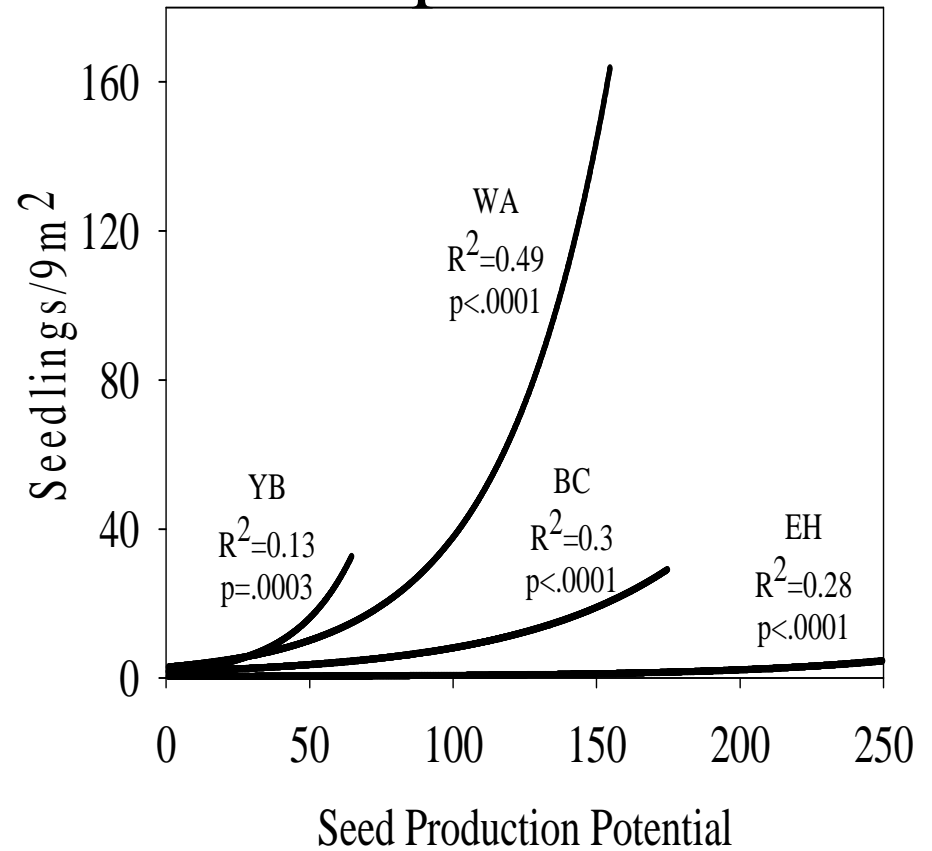




Ph. D. student John Willis
assessed the impact of local seed
sources on regeneration



Local Seed Sources are important

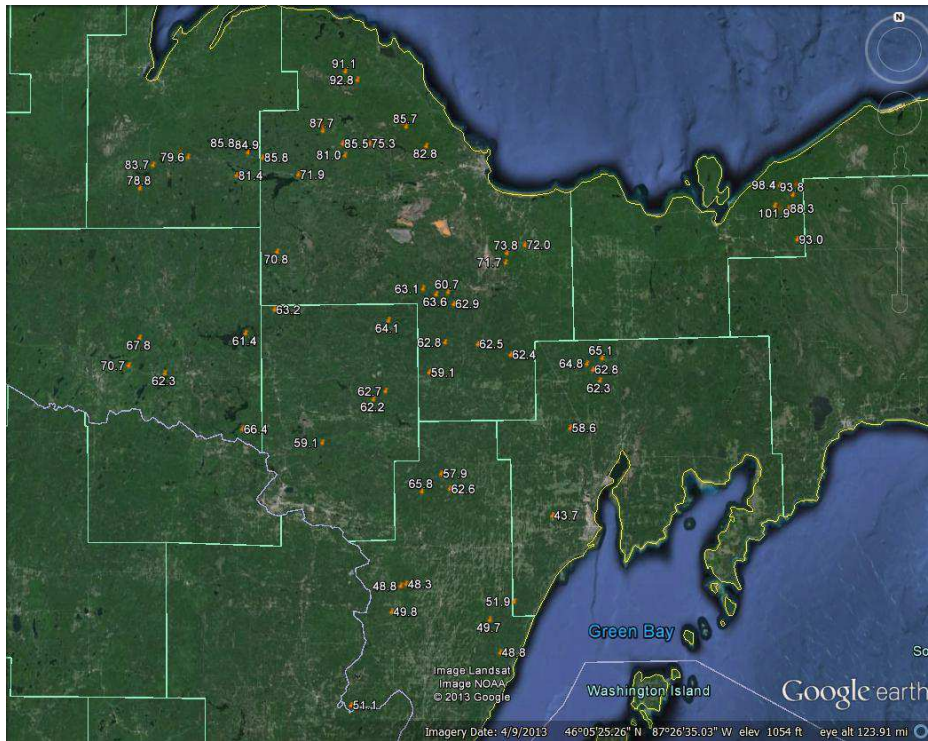


$(\sum \text{diameter}^2 / \text{distance}^2)$ all trees
 Within 50 meters of seedling plots

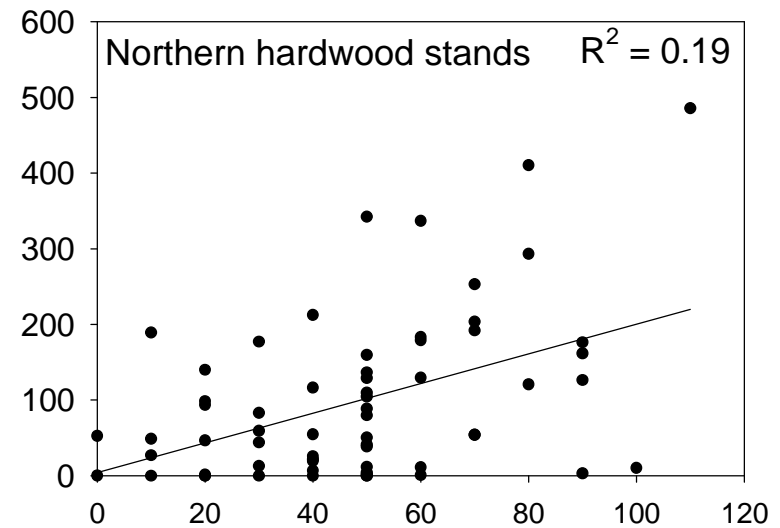
Lack of a local seed source can be a problem for some species in what are now northern hardwood stands. (based 191 stands in west-central upper peninsula)

Basal area of trees > 4' dbh (22 species counted)

Sugar maple	72%
Basswood	13
Red maple	3
Yellow birch	2
Paper birch	2
Quaking aspen	1
Ironwood	1
Ash	1
Red oak	<1
Black cherry	<1
Balsam fir	<1
Eastern hemlock	<1, etc.....



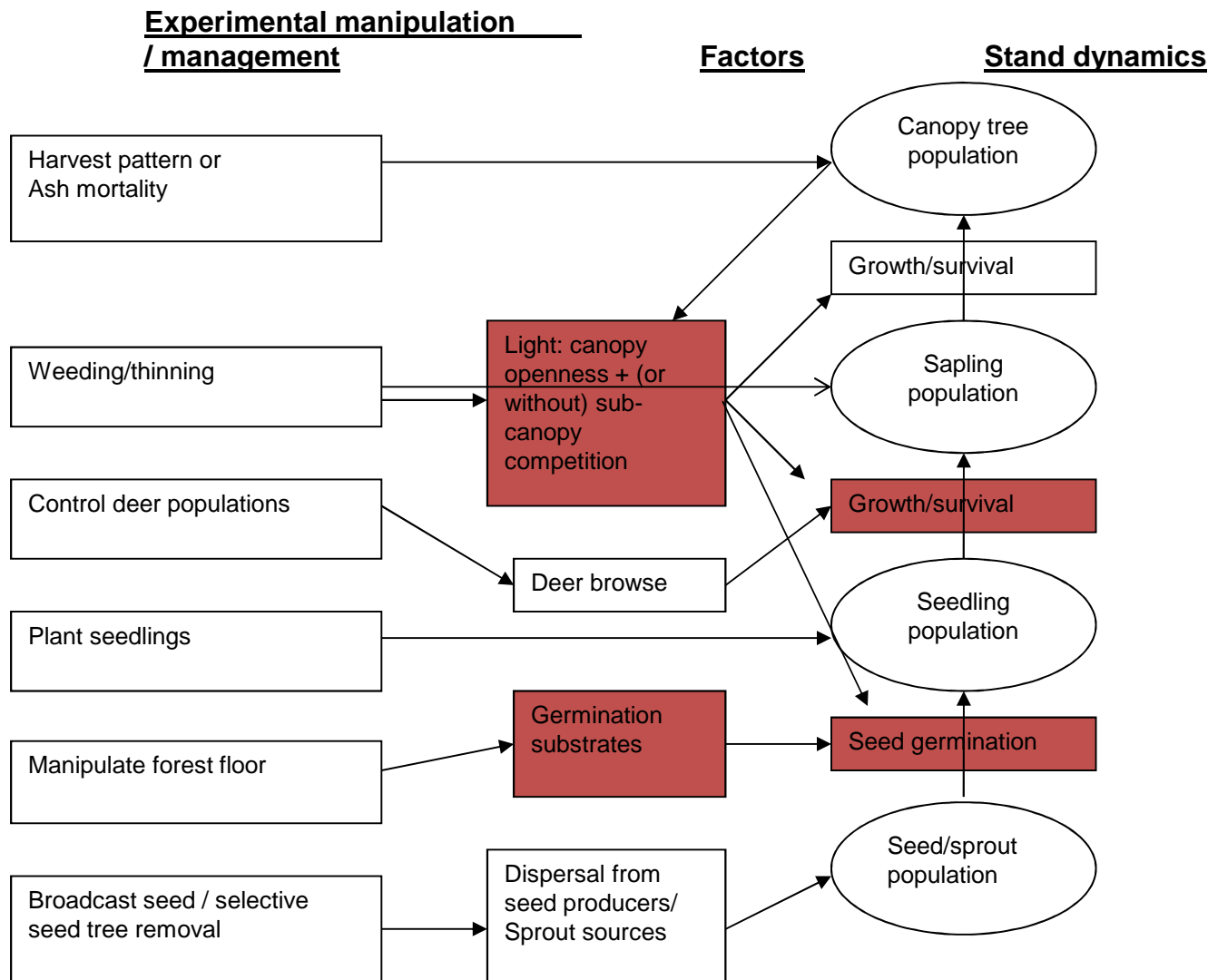
Sugar maple seedlings (per m²)



Basal area (ft²/acre) of sugar maple > 14" in 10 BAF prism sweep

Trees large enough to produce lots of seed may be necessary too..... but lots of other things going on to.

Do seedlings have the kinds of substrates and resources they need to get going?



Dominant seedling layer species in northern hardwood stands management mostly by selection silviculture



Sugar maple
(*Acer saccharum*)



American beech (*Fagus grandifolia*)



Ironwood (*Ostrya virginia*)



Red maple (*Acer rubrum*)

What do they have in common? Shade tolerant, large seeded

Less common seedling layer species



Paper birch (*Betula papyrifera*)



Eastern hemlock (*Tsuga canadensis*)



White pine (*Pinus strobus*)

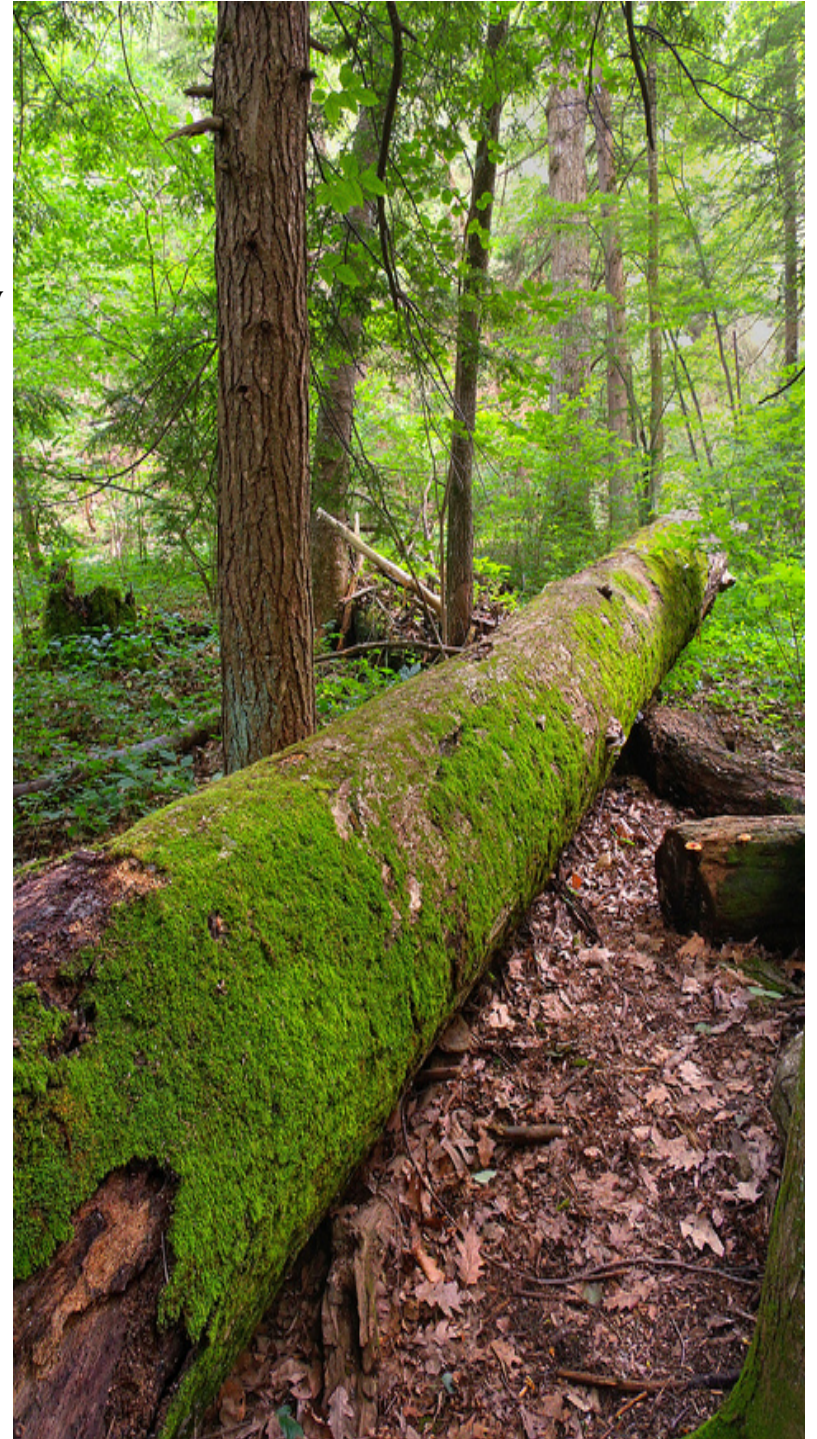


Yellow birch (*Betula alleghaniensis*)



Harvesting Legacies

Decline in Coarse Woody
Debris



Harvesting Legacy: Winter harvesting can causes minimal soil surface disturbance



Single Tree Selection Harvesting Legacy-low light availability



Light?

TOLERANT

INTOLERANT



EH

AB

SM

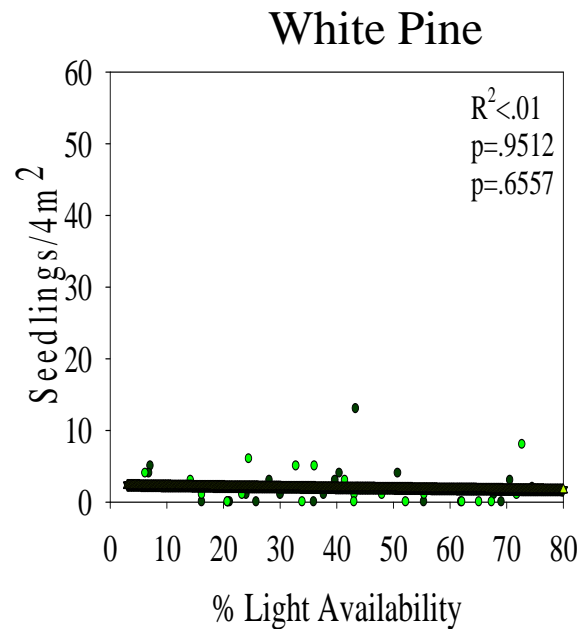
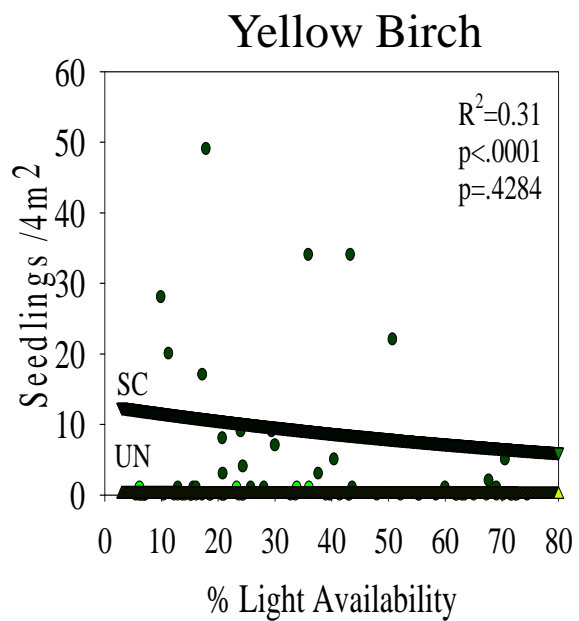
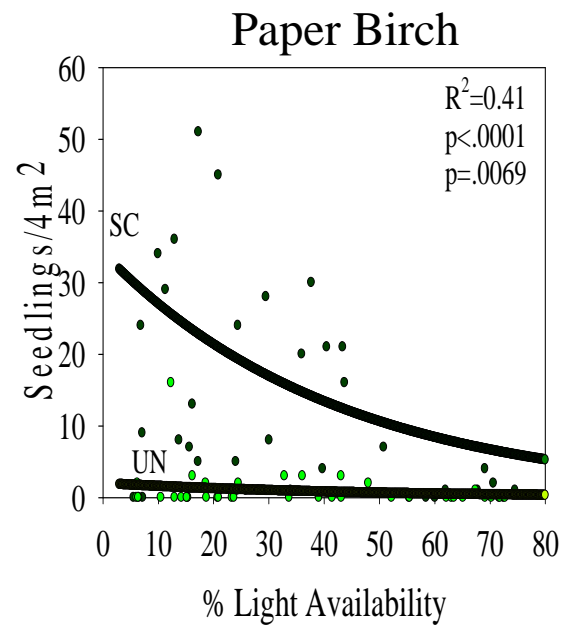
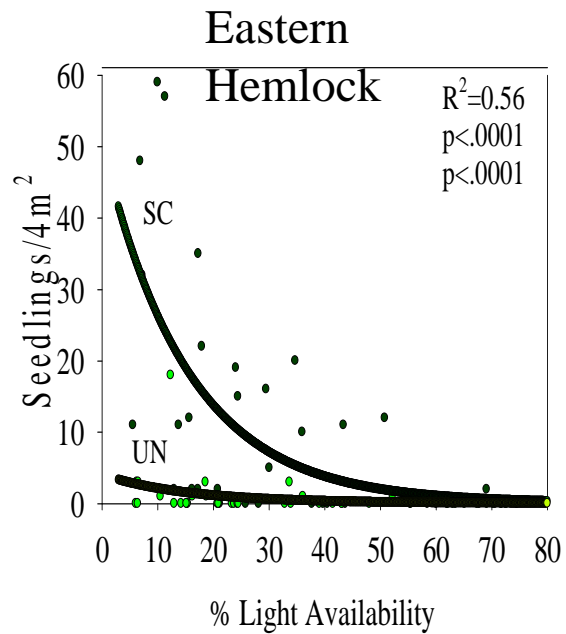
IW

RM

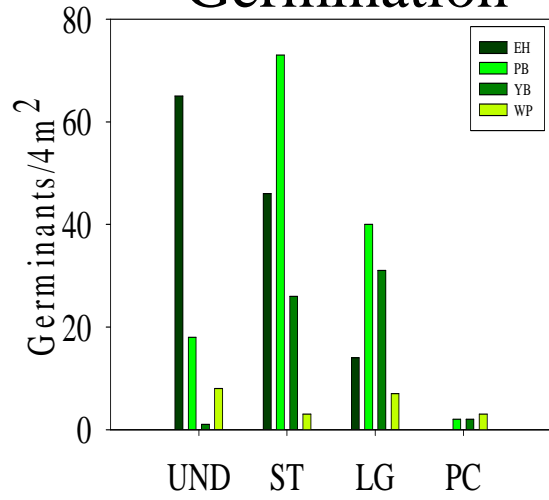
WP

YB

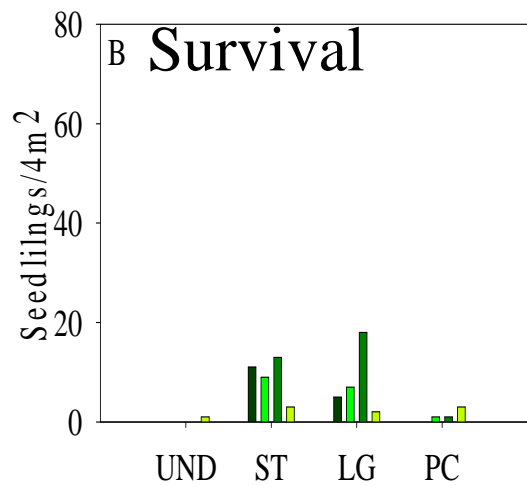
PB



Germination

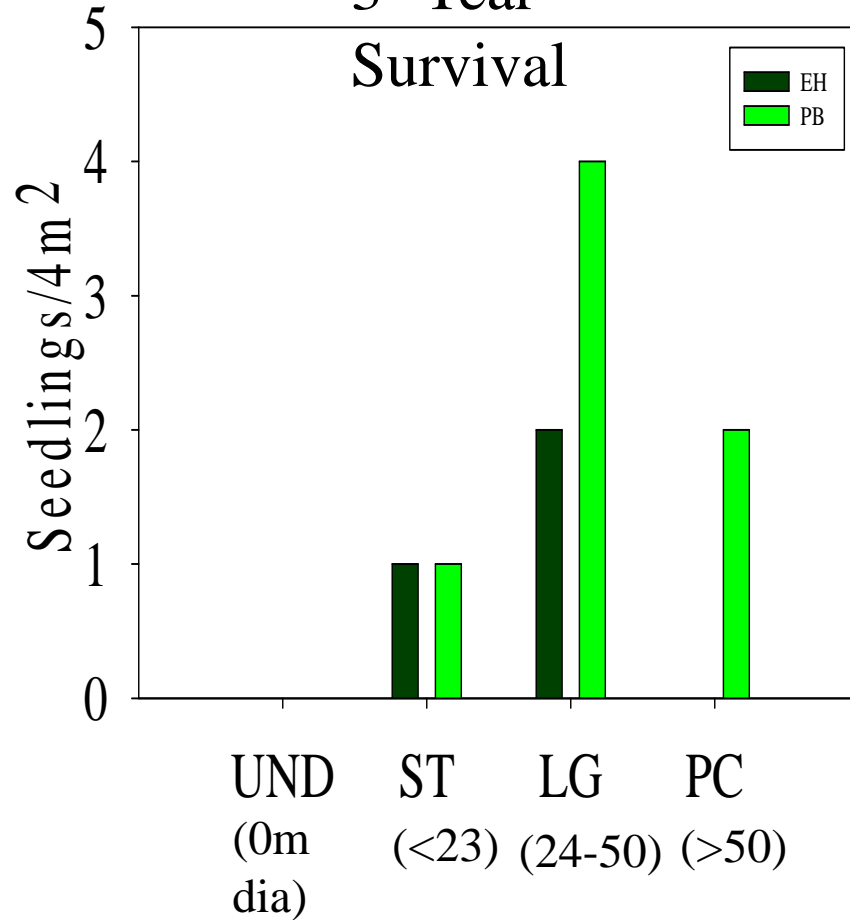


2nd Year

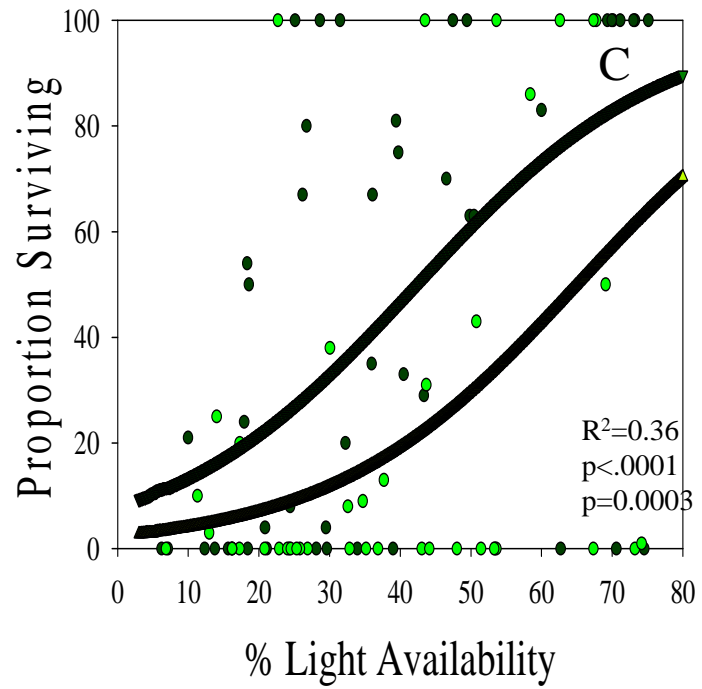


3rd Year

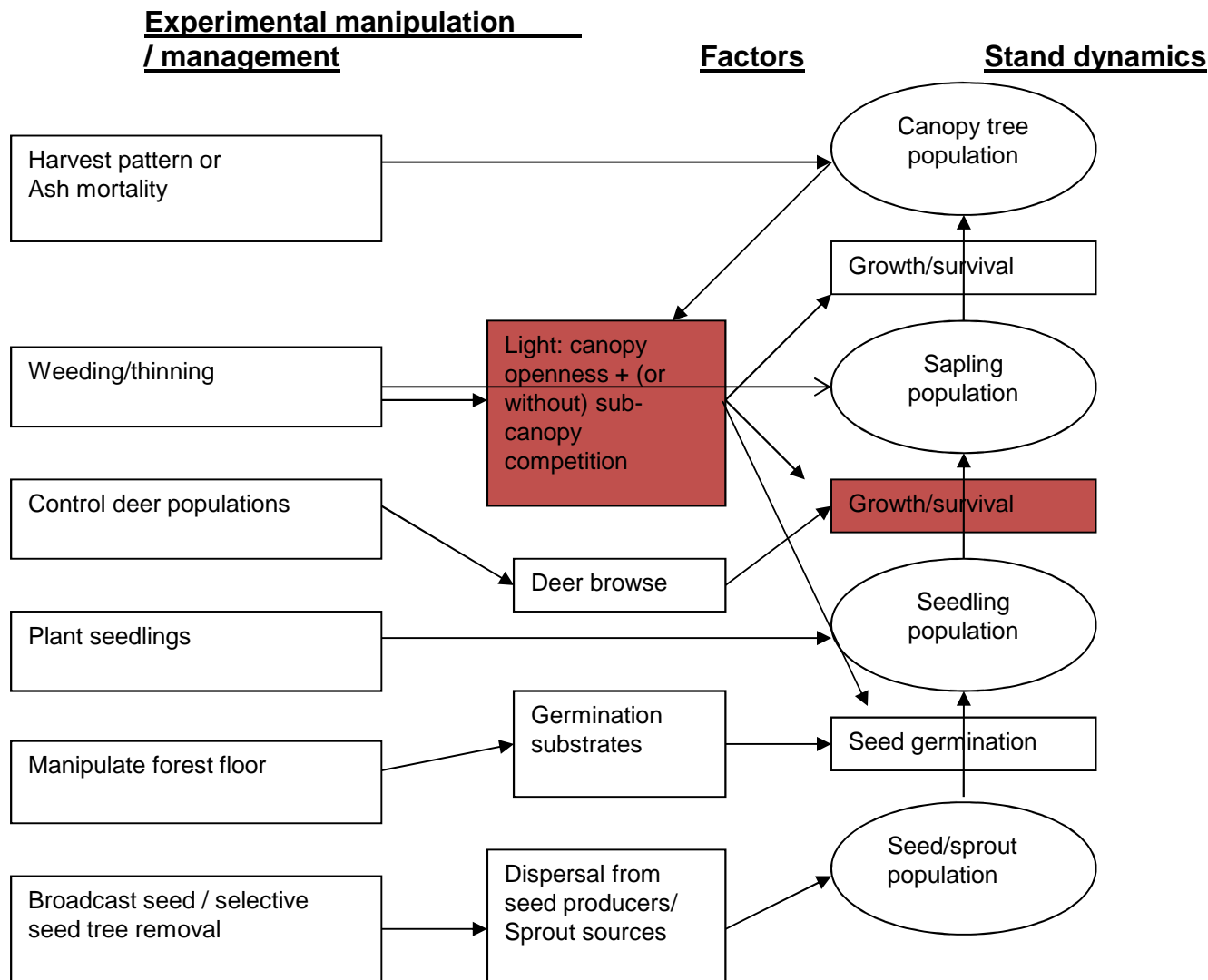
Survival



Effect of Clipping on Survival



Do seedlings have the kinds of substrates and light they need to get going?

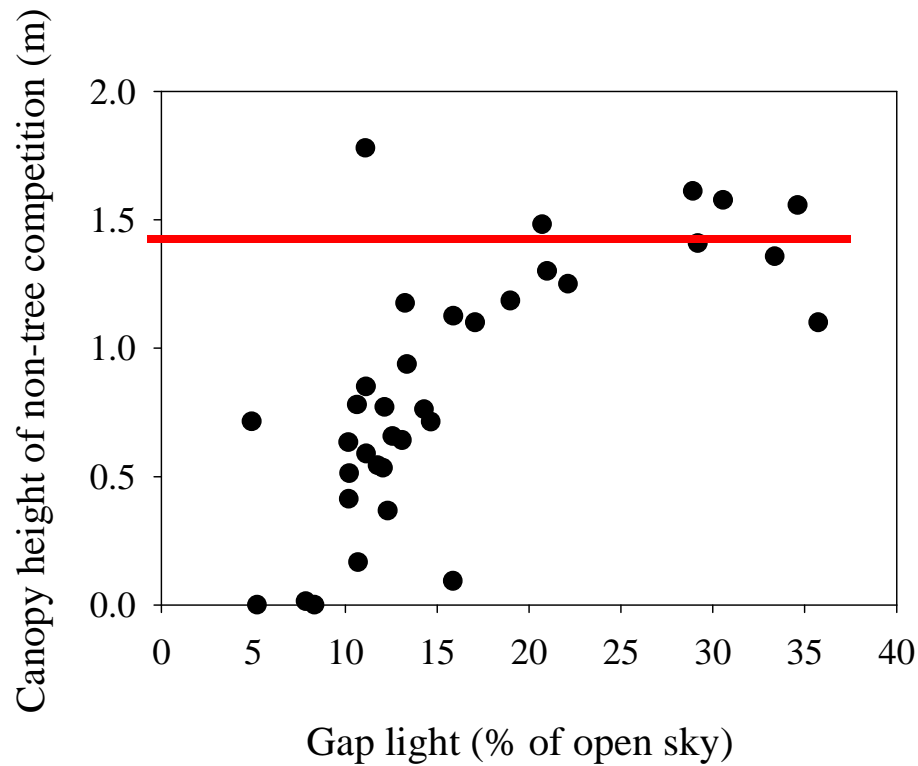




Fenced harvest gap, early second growing season



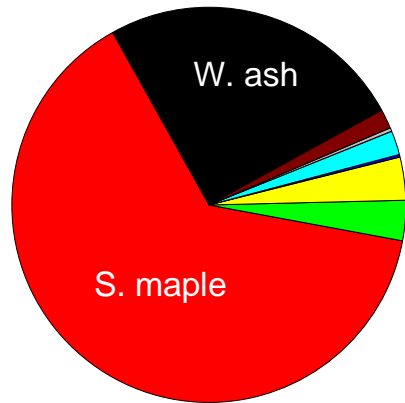
Fenced harvest gap, end of third growing season



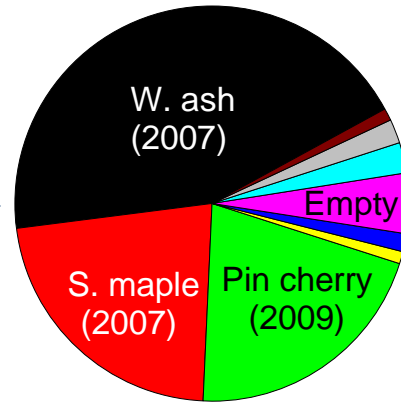
Mean canopy height of competing vegetation is a little taller than breast height.
Important for seedlings to tolerate (shade tolerant), avoid (shade intolerant) or grow tall faster than ascending competing vegetation following harvest

Advanced regeneration removed

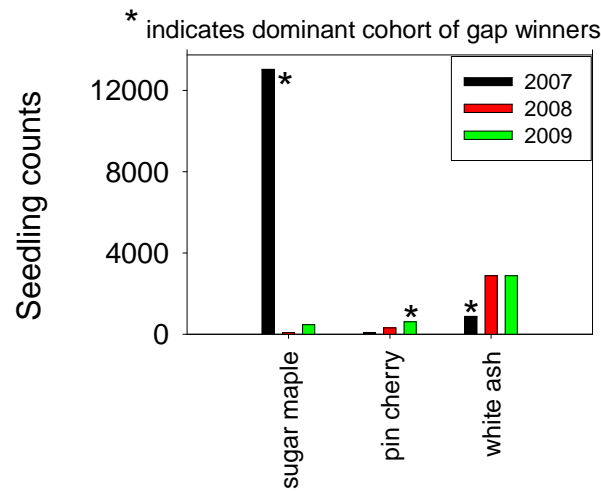
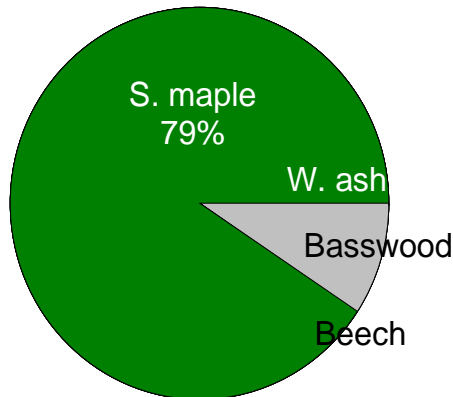
Seedlings
2007-09



Fenced
Winners 2012



Overstory



- 85% of post-harvest seedlings (22,270 tallied, 214,000/acre) were of just two species.

- Stocking of seedlings is high, but diversity is low
- Gap winners disproportionately ash and pin cherry. Why? rapid growth for pin cherry and ash, slow growth and 90% mortality for maple
- Ash nearly completely dominates if deer are not excluded.

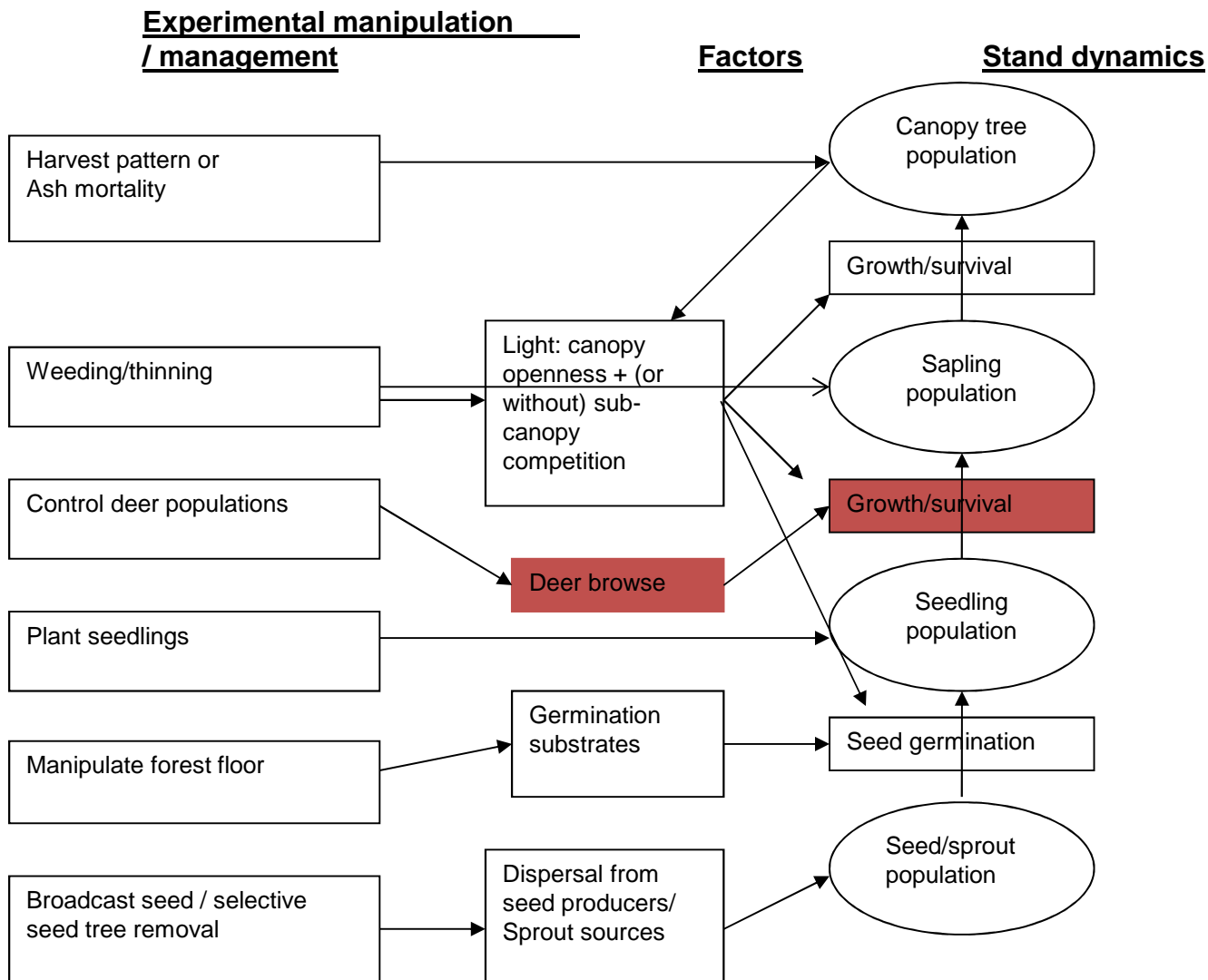
Pin cherry dominating gap, 8 years after harvest



White ash doing the same



But what about deer?



Paper birch, repeatedly snarfed, beech and white spruce untouched



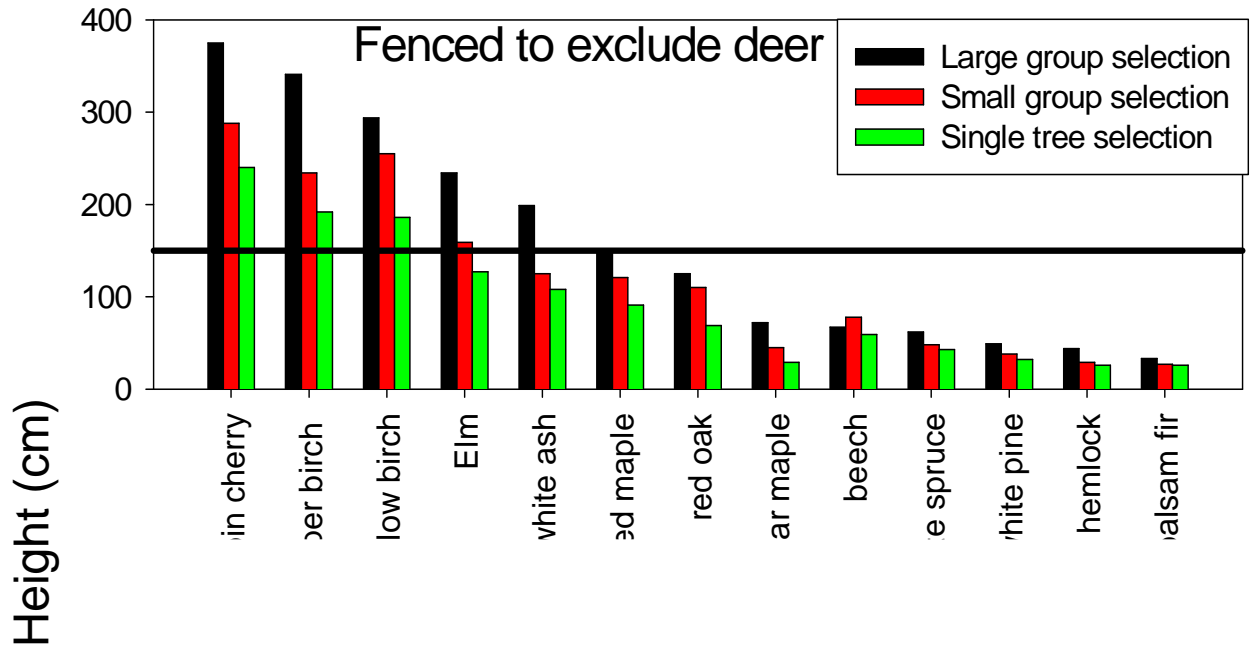
Unhappy yellow birch



White pine lookin' fine.

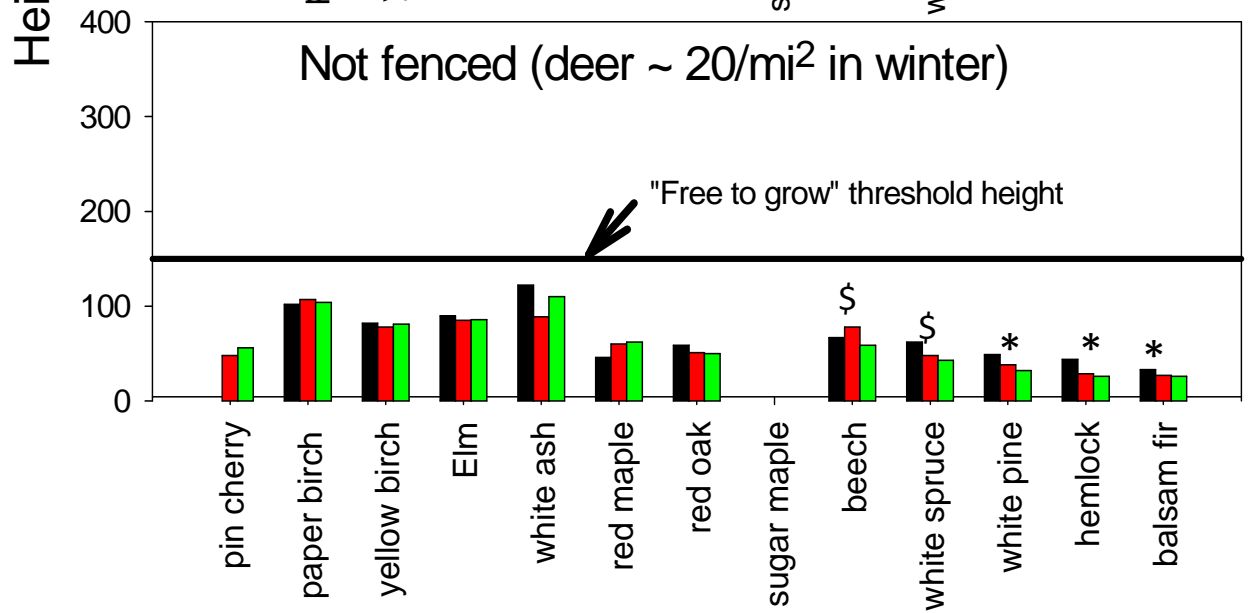
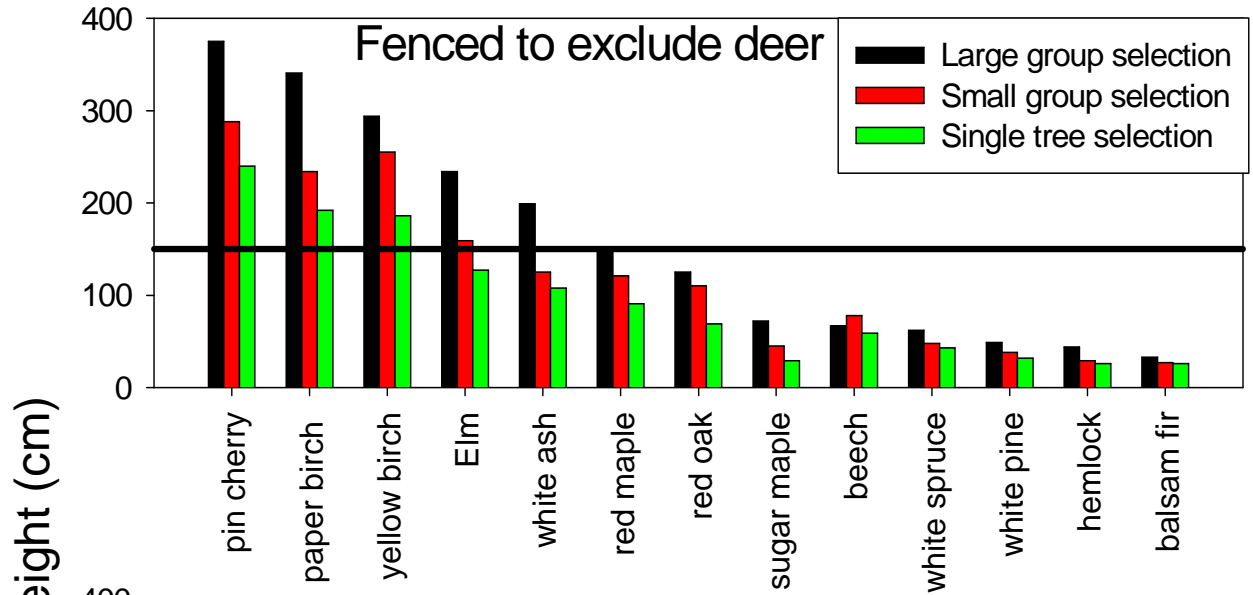


Planted seedlings, kept weeded. Six years old



Desirable species such as paper and yellow birch need be fenced 4-5 years, other species longer

Planted seedlings, kept weeded. Six years old

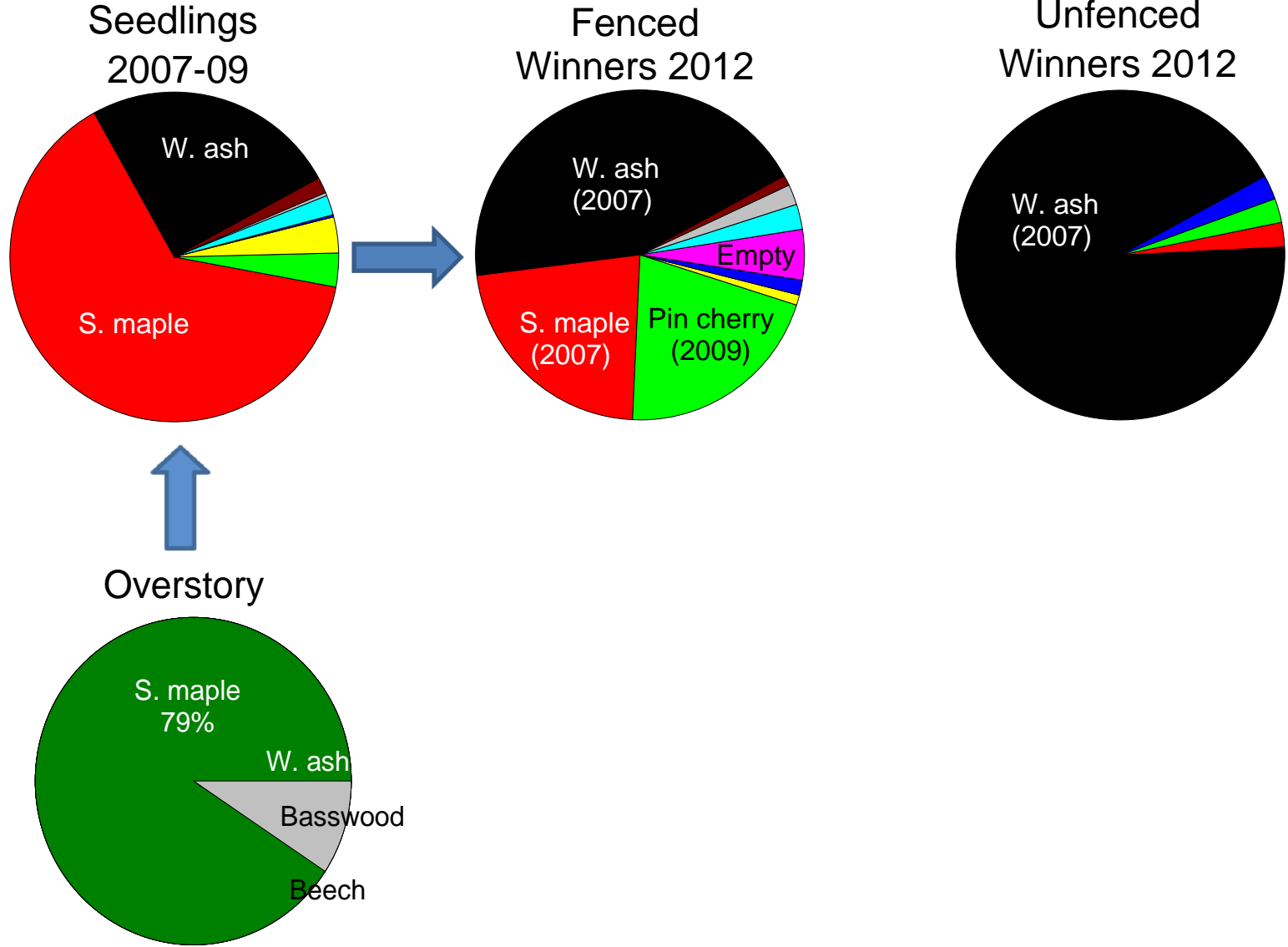


If not fenced, attaining free growth is, at the least, slowed down... ash now the tallest

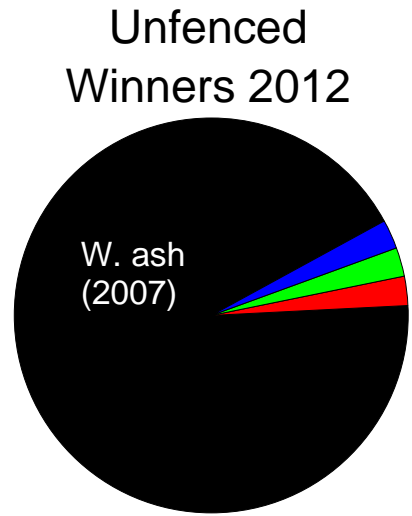
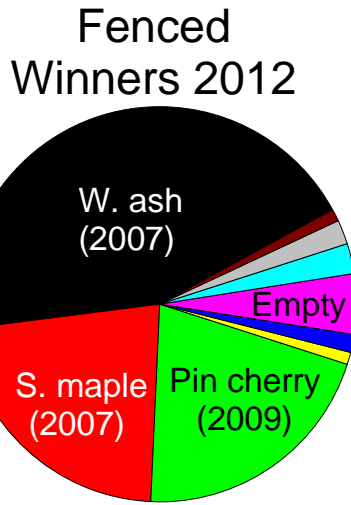
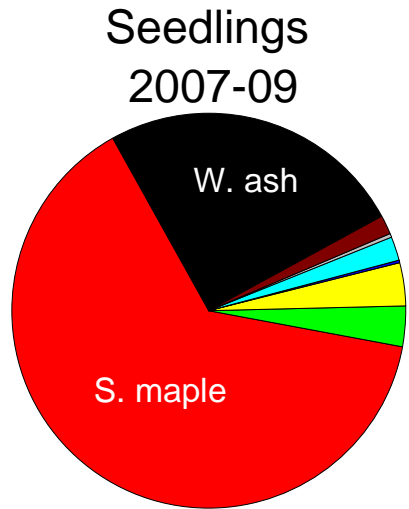
* browse damage observed, but no effect on height yet

\$ browse damage not observed

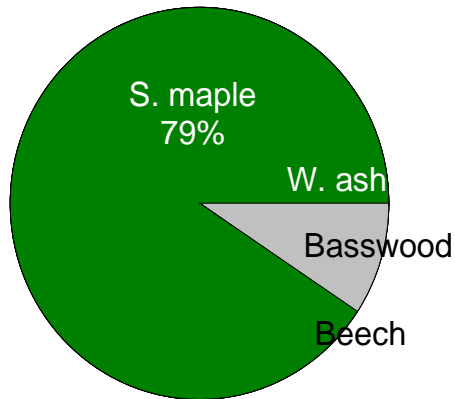
Advanced regeneration removed



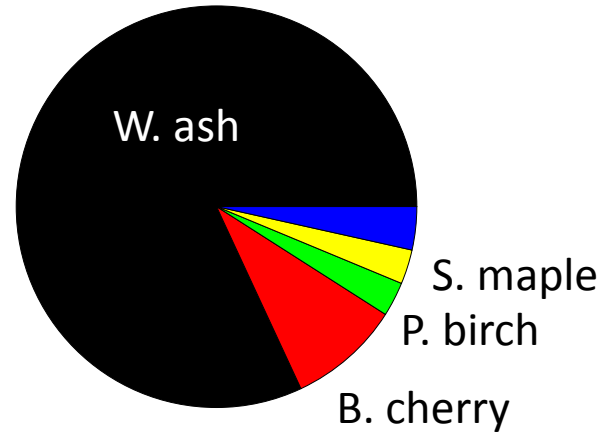
Advanced regeneration removed



Overstory




MDNR Site: 2014, fenced and unfenced pooled



White ash sapling: natural regeneration, unfenced



What factors are affecting dominance of most common species

- Clear that advanced regeneration favors beech and ironwood.
- Without advanced regeneration 

Pin cherry:

Gap size: +

Deer: -

Soil moisture -

Sugar maple:

Gap size: +

Deer: 0 (but seedlings still small)

Soil moisture: 0

White ash:

Gap size: 0

Deer: +

Soil moisture: +

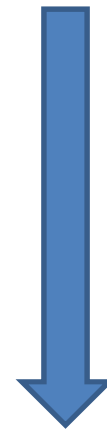
Why ash wins (in medium term in stands with local ash seed sources)

- Produces lots of seed with relatively long viability (3 years +)
- Some seedlings able to stay above developing competing vegetation via rapid height growth
- Not browsed heavily by deer so realized height growth greater than other species
- Shade tolerant as a young seedling so can dominate all but smallest gaps over the medium term (8 yrs..+). Longer, who knows

Many factors conspiring against increasing tree diversity in northern hardwood stands

- Lack of local seed sources
- Lack of substrates for establishment
- small harvest gaps
- Competing vegetation
- Deer

20+ species

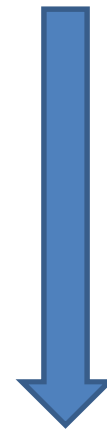


Beech, ironwood, ash

Many factors conspiring against increasing tree diversity in northern hardwood stands

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Beech, ironwood, ash

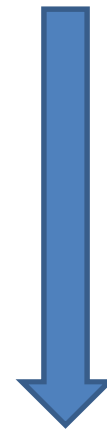
Management conclusions for increasing diversity:

- Natural regeneration from seed heavily dominated by very few species has to be overcome
- Recognize when conducting early regeneration surveys that advanced regeneration and the first seedlings to establish post-harvest will dominate future stocking.
- Consider weeding if advanced regeneration stocking is dominated by undesirable species (it will win! And it often sucks). Herbicide control of 1-2" dbh regeneration is highly effective.

Many factors conspiring against increasing tree diversity in northern hardwood stands

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- small harvest gaps
- Competing vegetation
- Deer

20+ species



Beech, ironwood, ash

