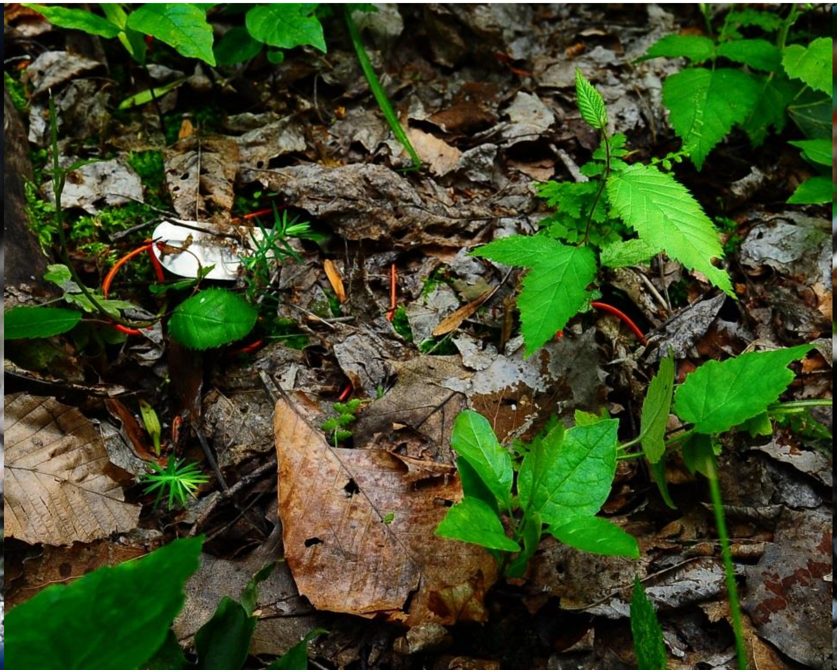
The Influence of Forest Substrate on Young Seedling Dynamics

John L. Willis, Forestry, Michigan State University, East Lansing, Michigan
Michael B. Walters, Forestry, Michigan State University, East Lansing, Michigan
Kurt W. Gottschalk, USDA Forest Service Research Station, Morgantown, West Virginia



Outline

Current seedling demographics

Management strategies and assumptions

Substrate case study 1: soil availability influence seedling establishment within harvest gaps

Substrate case study 2: mechanisms of seedling survival and development on different types of forest substrate (preliminary)

Questions

Species Depauperate Seedling Layer

(Matonis et al. 2011)

Varying Harvest Gap Size

(Shields and Webster 2007; Bolton and D'Amato 2011; Kern et al. 2013)

Assumption #1

Desired species already are/will become established in harvest gaps


The Life Cycle of a Tree
Sprout
Seed
Sapling
Snag
Mature Oak

Germination Substrate

Easily penetrated by roots

High moisture holding capacity (clays>silt>sand)

Majority of plant available nutrients

Harvesting Legacy #1 reduced bare mineral soil/humus

-Removing mature, suppressed, diseased trees

-Harvesting in the winter

Assumption #2

Desired species will have access to light within harvest gaps

Access to Light

Competing non-tree vegetation

Density and height correlate positively with gap size

Herbivory

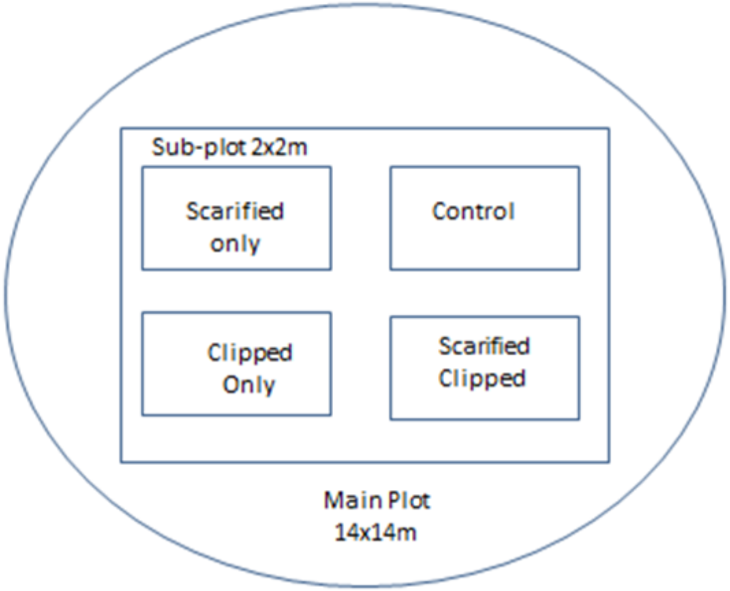
Loss of aboveground biomass

40 acre rich mesic northern hardwood stand

Emmet County, Michigan

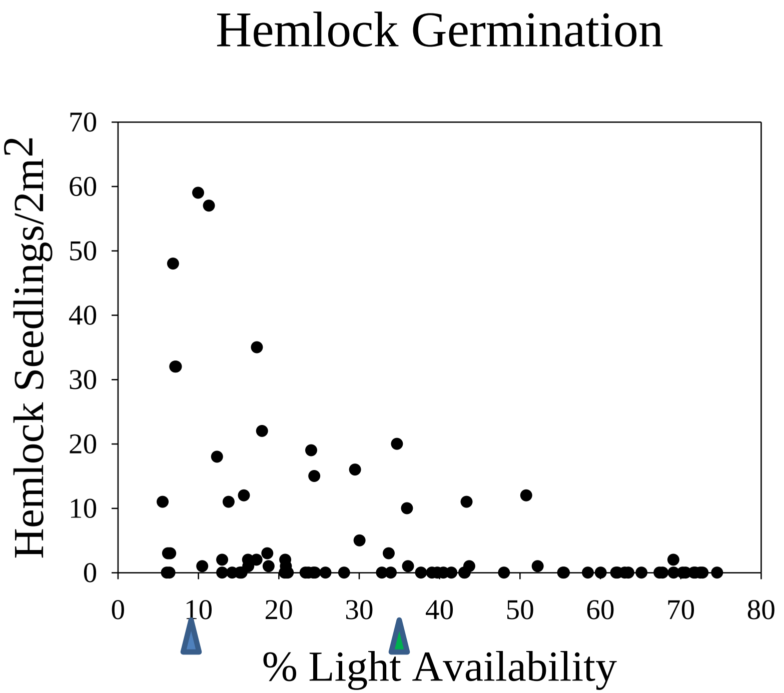
Continuous range of gap sizes from single-tree gap to 1.58 acres and four unharvested understory plots

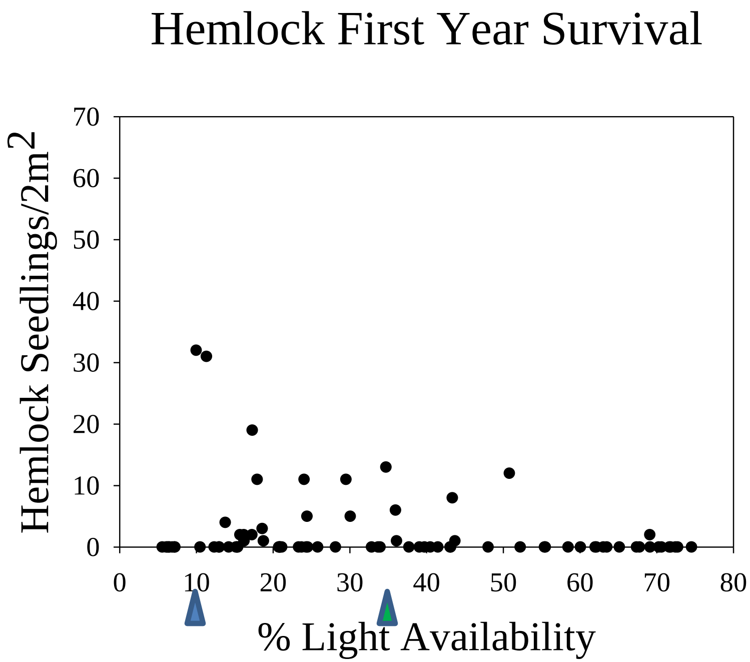

Sub-plot 2x2m
Scarified only
Control
Clipped Only
Scarified Clipped
Main Plot 14x14m

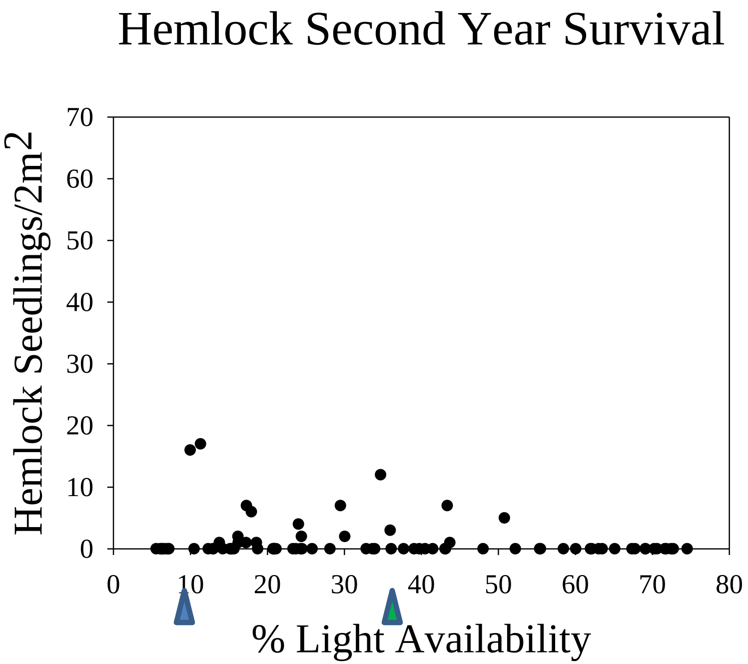
% Light Availability
(modified by overstory and forest floor vegetation)

Substrate Coverage
(% cover)

Non-Tree Vegetation
(% cover and height)



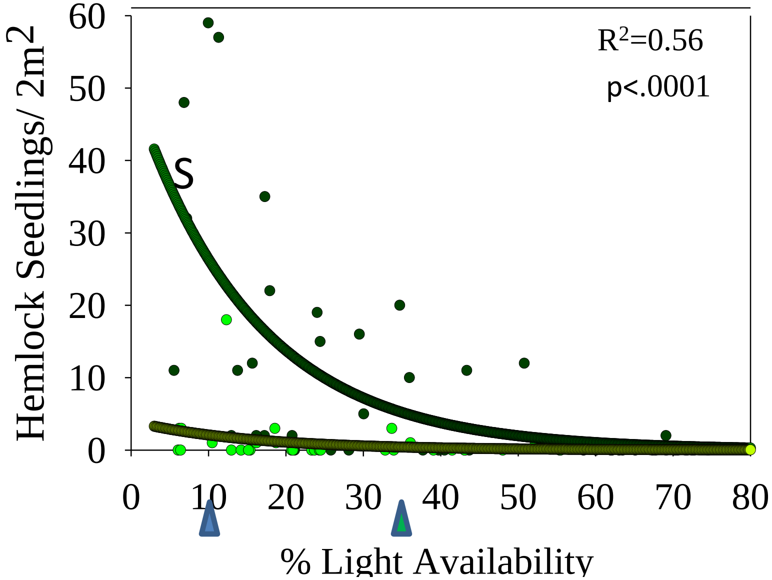




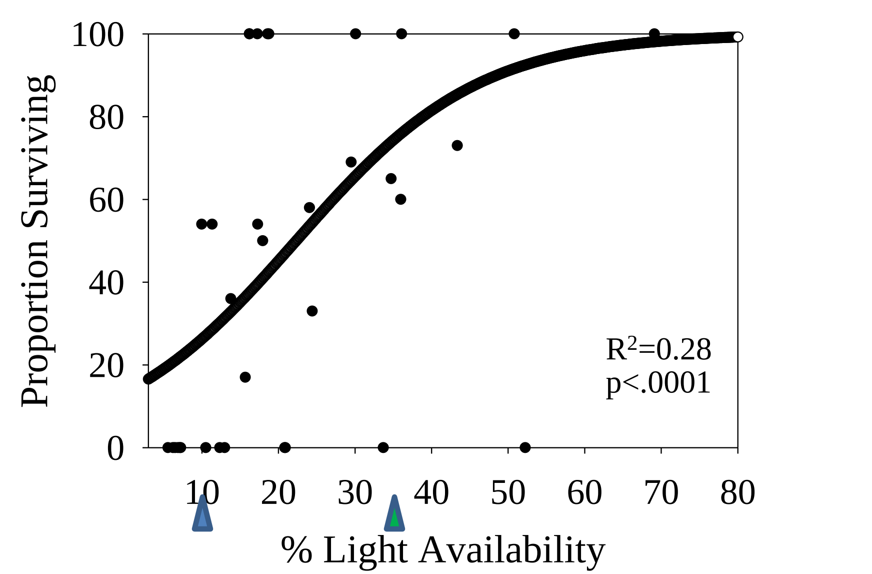
ST(<.1ac) GS (.1-.5) PS (.5-2)

Eastern Hemlock (*Tsuga canadensis*)

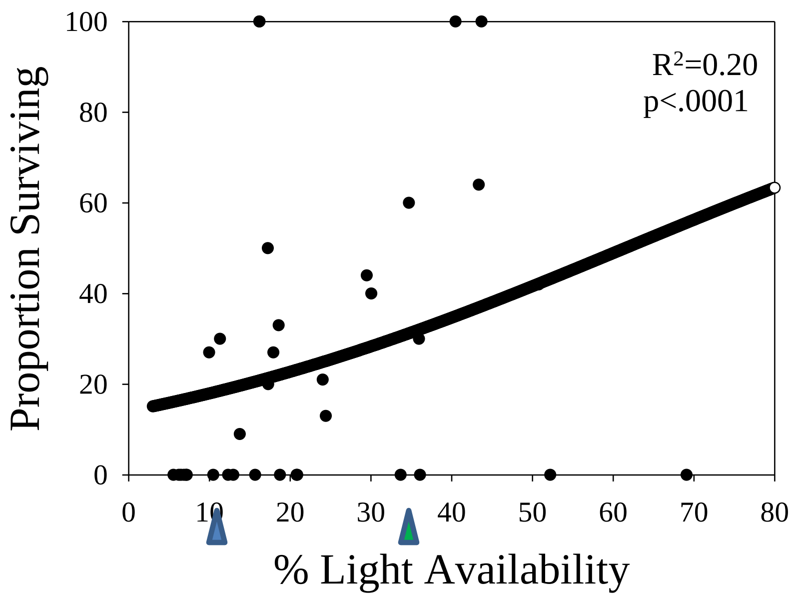
Effect of Scarification on Germination



Effect of Light Availability on Survival (Year 1)



Effect of Light Availability on Survival Year (2)



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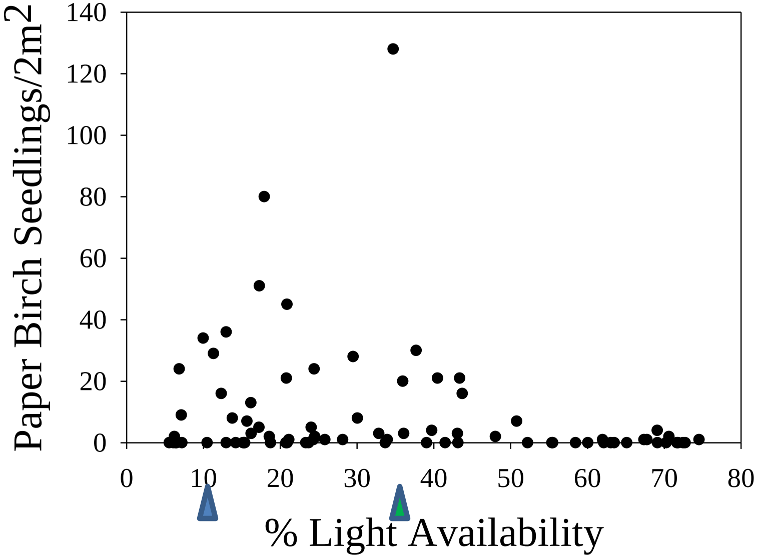
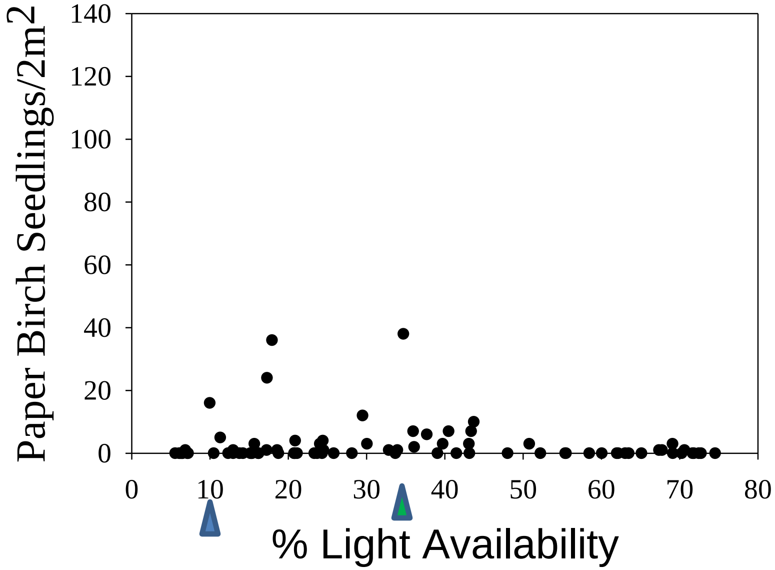
Eastern Hemlock (*Tsuga canadensis*)

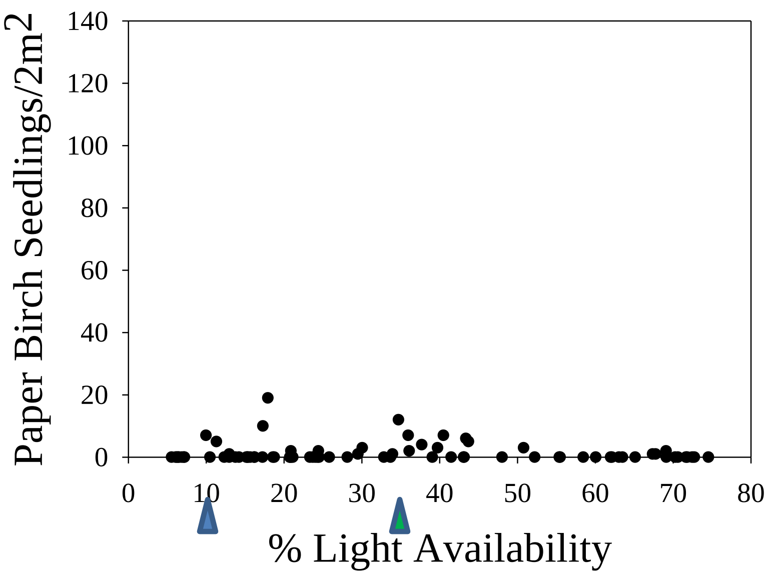
Paper Birch Germination



Paper Birch First Year Survival



Paper Birch Second Year Survival



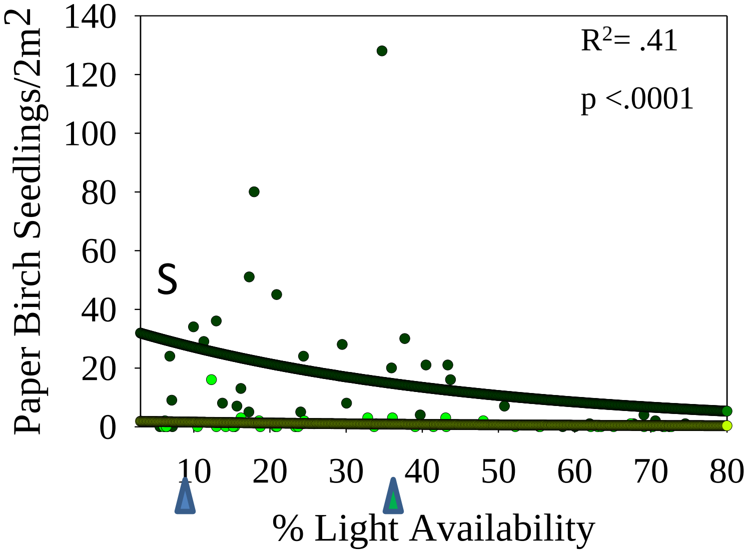
ST(<.1ac)

GS (.1-.5)

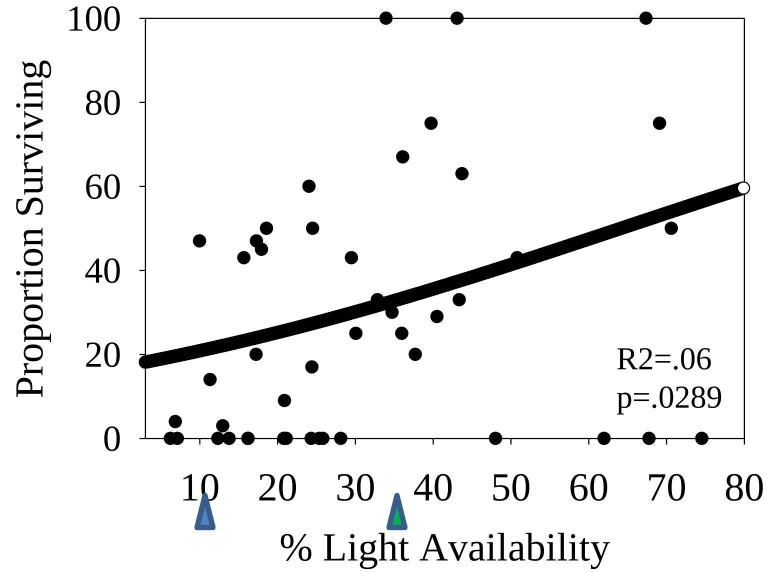
PS (.5-2)

Paper birch (*Betula papyrifera*)

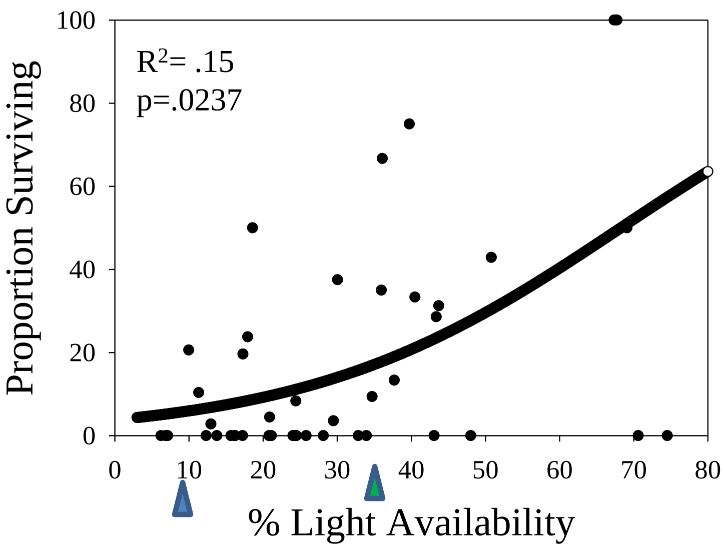
Effect of Scarification on Germination

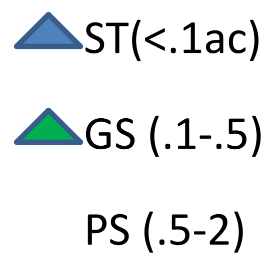


Effect of Light Availability on Survival (Year 1)



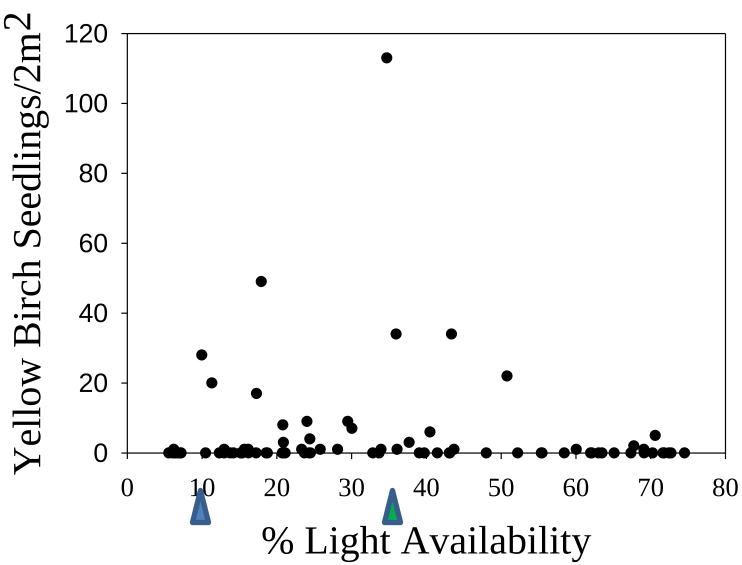
The Effect of Light Availability on Survival (Year 2)



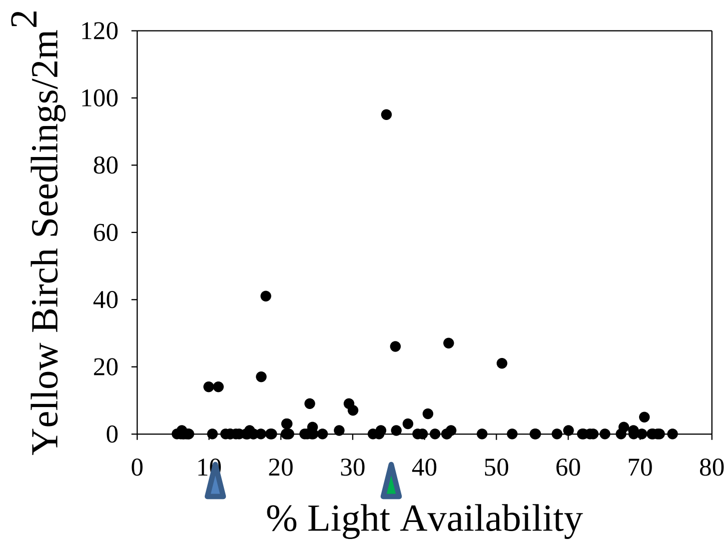


Paper birch (*Betula papyrifera*)

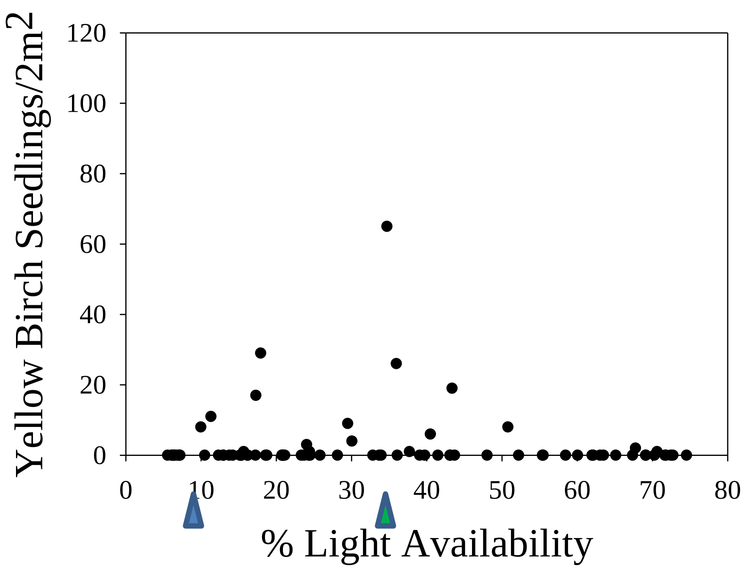
Yellow Birch Germination



Yellow Birch First Year Survival



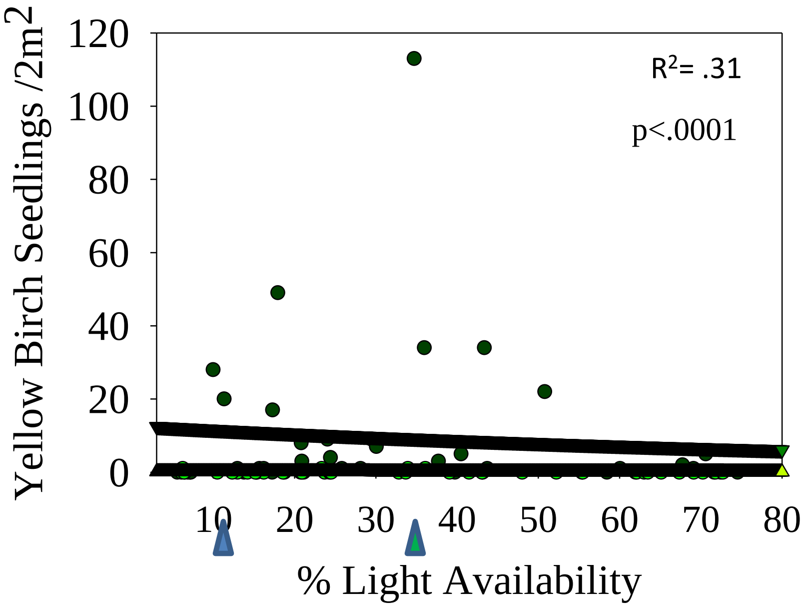
Yellow Birch Second Year Survival



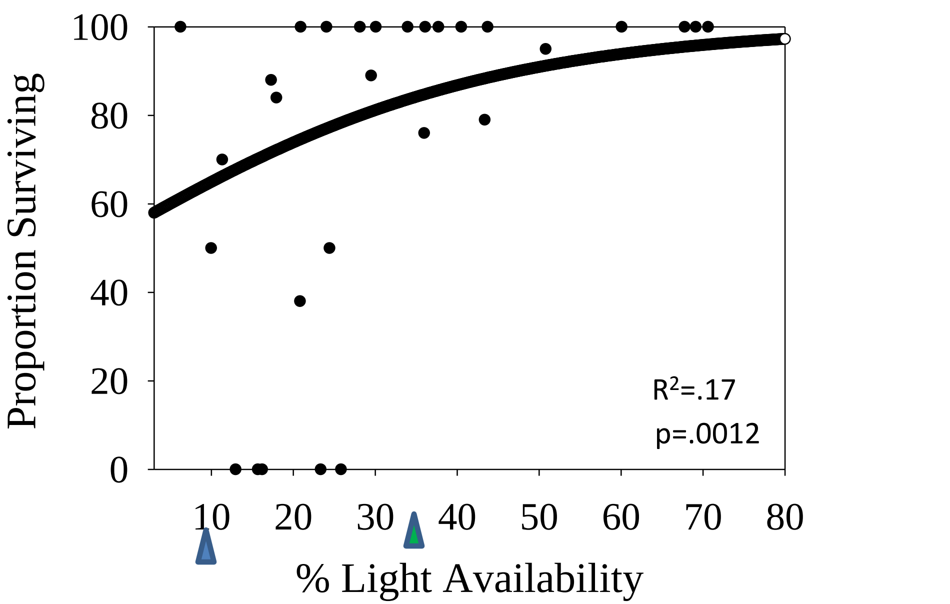
ST(<.1ac) GS (.1-.5) PS (.5-2)

Yellow Birch (*Betula alleghaniensis*)

Effect of Scarification on Germination



Effect of Light Availability on Survival (Year 1)



ST(<.1ac)

GS (.1-.5)

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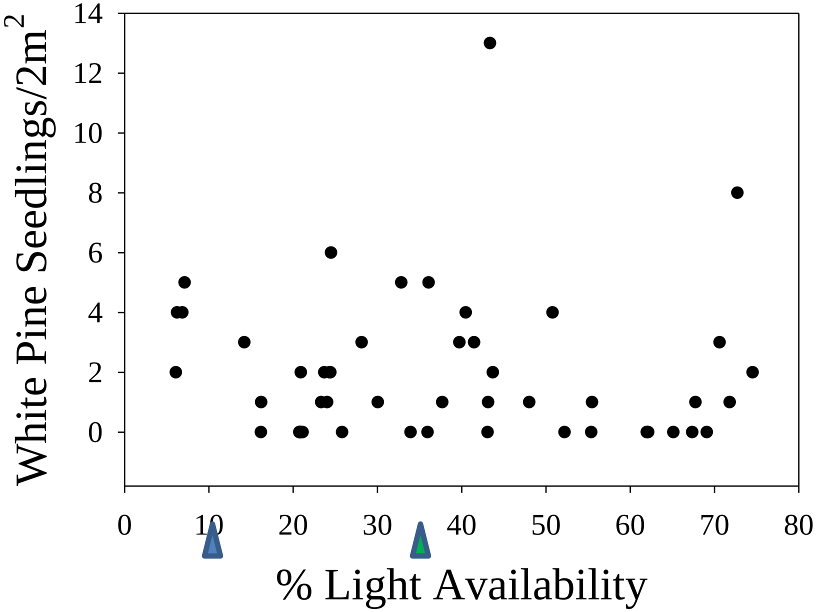
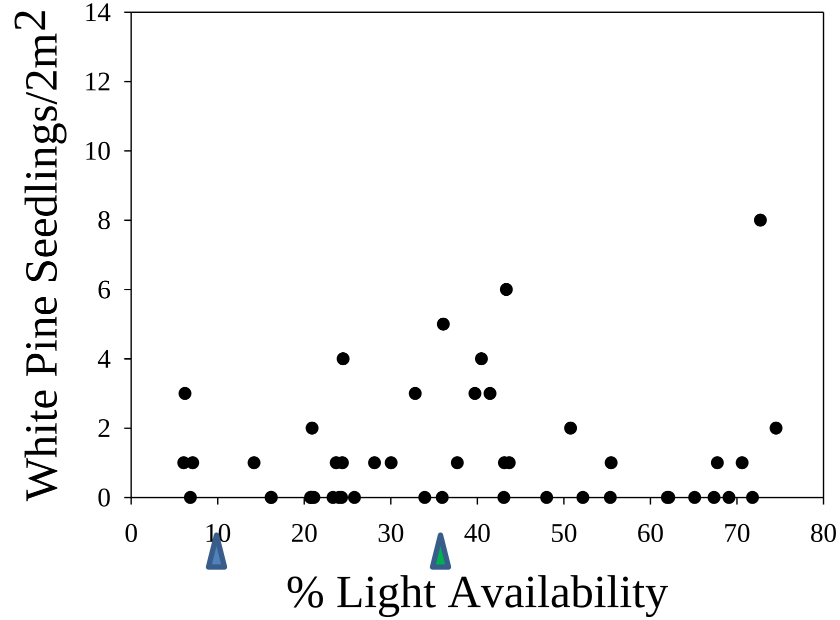
Yellow birch (*Betula alleghaniensis*)

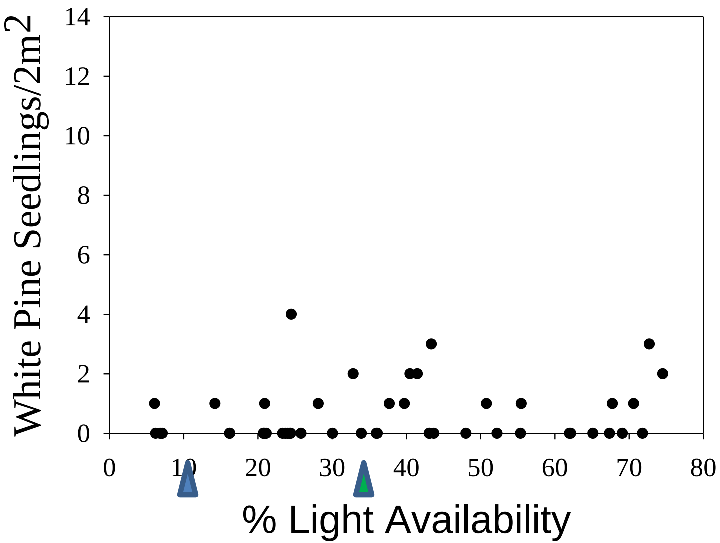
White Pine Germination



White Pine First Year Survival



White Pine Second Year Survival



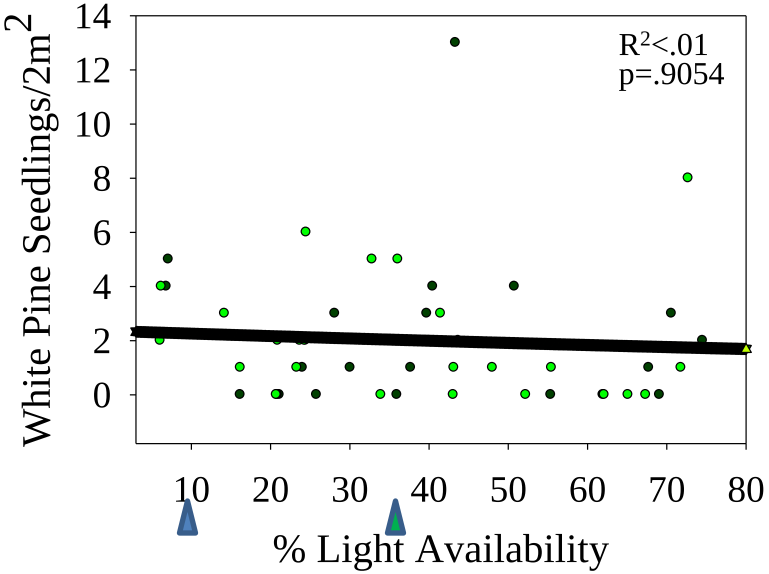
ST(<.1ac)

GS (.1-.5)

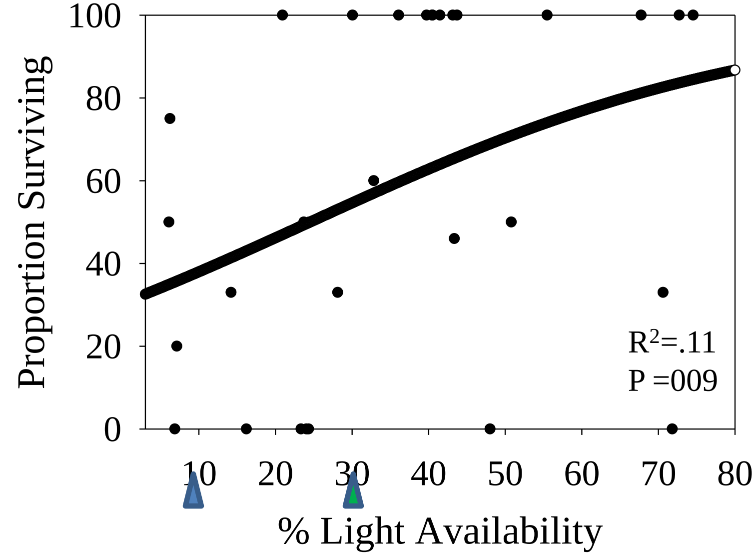
PS (.5-2)

White Pine (*Pinus strobus*)

Effect of Scarification on Germination



White Pine 1st Growing Season Survival



ST(<.1ac)

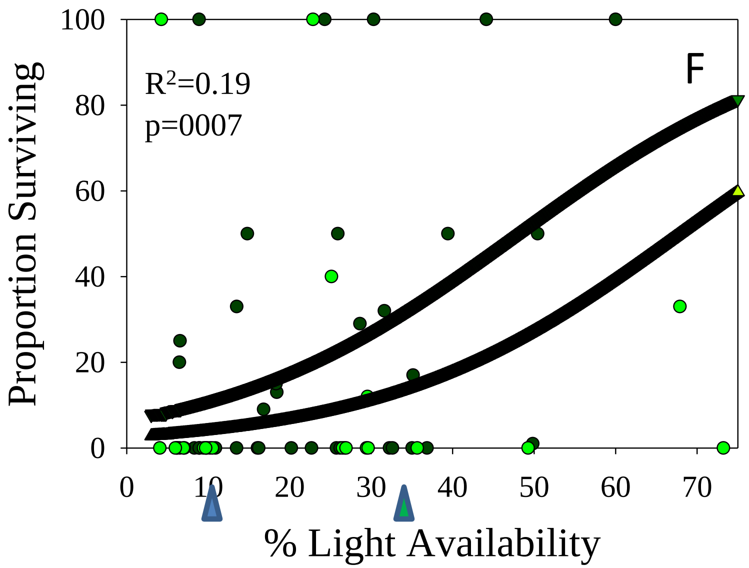
GS (.1-.5)

PS (.5-2)

White pine (*Pinus strobus*)

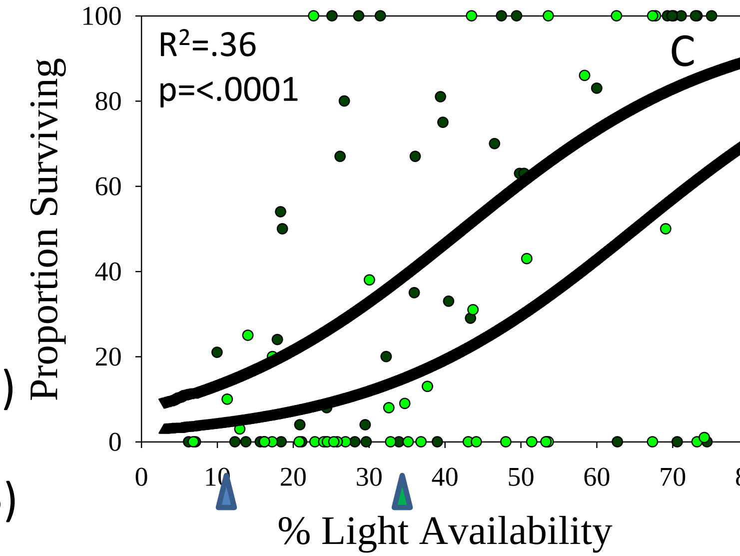
Hemlock

Effect of Fencing on Survival (Year 3)



Paper Birch

Effect of Clipping on Survival

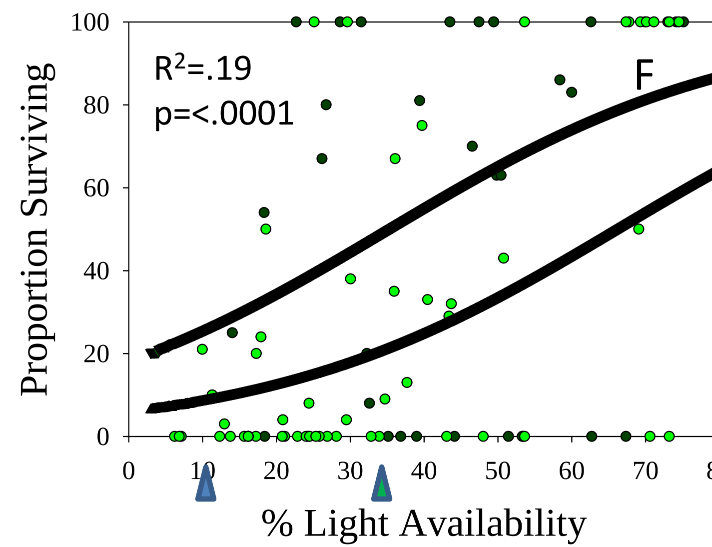


ST(<.1ac)

GS (.1-.5)

PS (.5-2)

Effect of Fencing on Survival



Conclusions

-Bare mineral soil/humus is CRITICAL for light seeded species germination, but not white pine.

-Low light availability is NOT a significant barrier to germination

-Increasing harvest gap size IMPROVES seedling survival for all species initially, but deer and non-tree vegetation are beginning to influence seedlings access to light(hemlock and paper birch)

-Group selection harvest gaps (.1-.5ac) may present the best opportunity to recruit this group of species….stay tuned

Case Study# 2: Seedling development across substrates

Harvesting/thinning reduces interrupts the cycle of nurse log creation by:

-Removing mature/diseased/suppressed trees

Decaying Coarse Woody Debris (Nurse Logs)

Hardwood litter avoidance

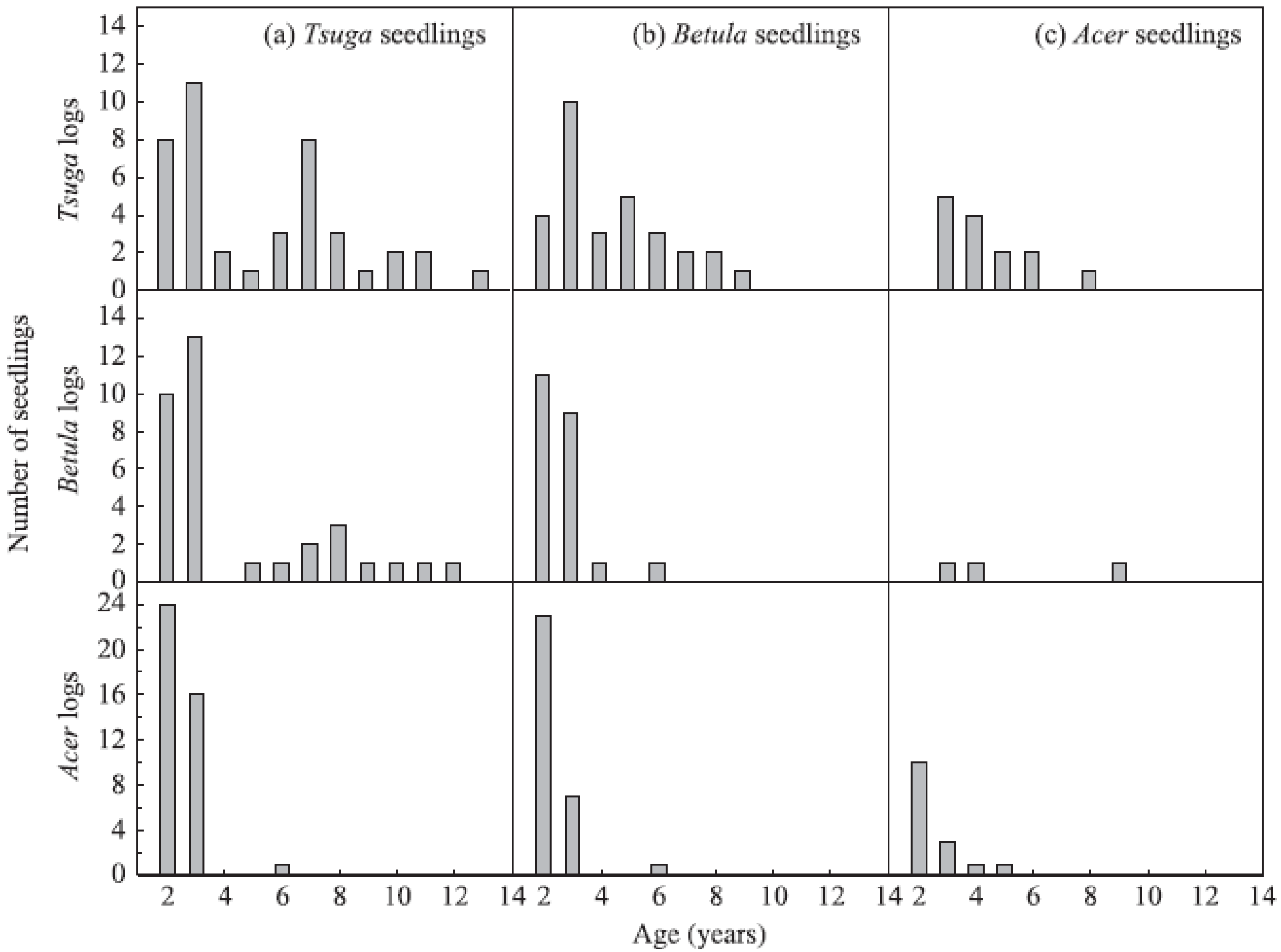
Competition from non-tree vegetation

Species specific pests/pathogens escape

Drought stress

(Harmon and Franklin 1989)

Nurse Log Seedling Demographics



1.Sugar Maple provides poor substrate for all species of seedlings

2. Hemlock most capable of surviving on nurse logs

3. Sugar maple least capable of surviving on nurse logs

4. Yellow Birch is better adapted for surviving on hemlock nurse logs

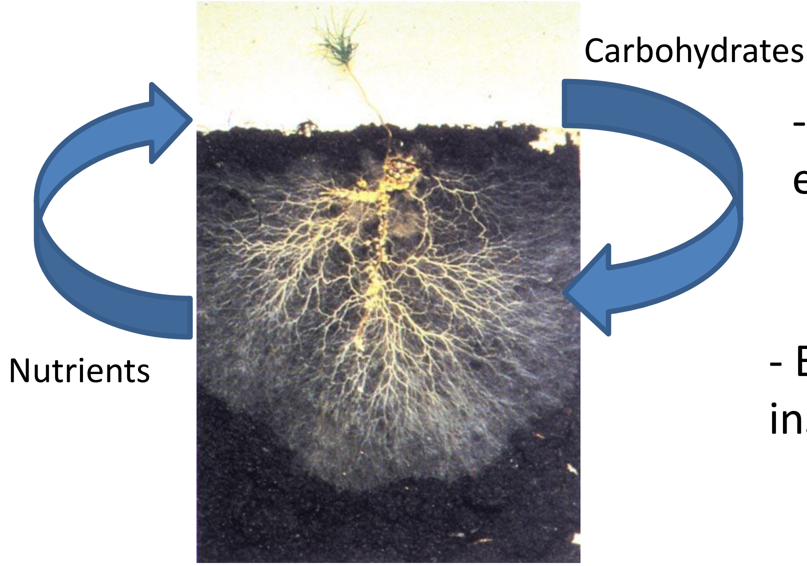
(Marx and Walters 2008)

Nutrient Limitation

Substrate	[N], µg/ml	Nmin µg.ml-1.day-1	pH
Hemlock wood	1.5	0.115	3.7
Yellow birch wood	2.45	0.018	3.9
Sugar maple wood	3.18	0.019	6.4
Soil	3.62	0.19	3.4

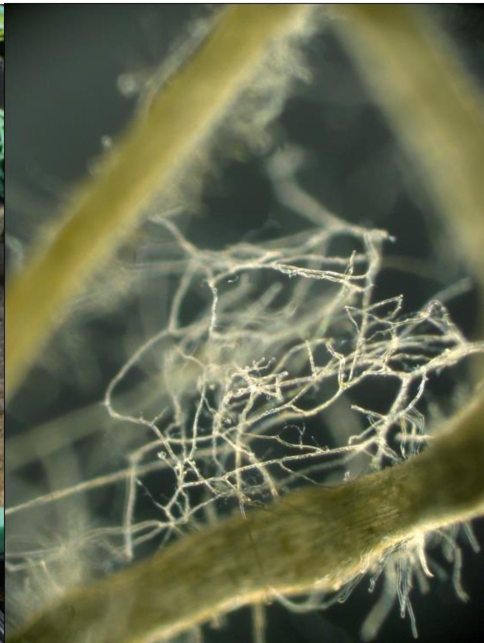
(Marx and Walters 2006)

Nutrient Extraction



-Increased volume of soil explored

- Breaking down previously insoluble compounds



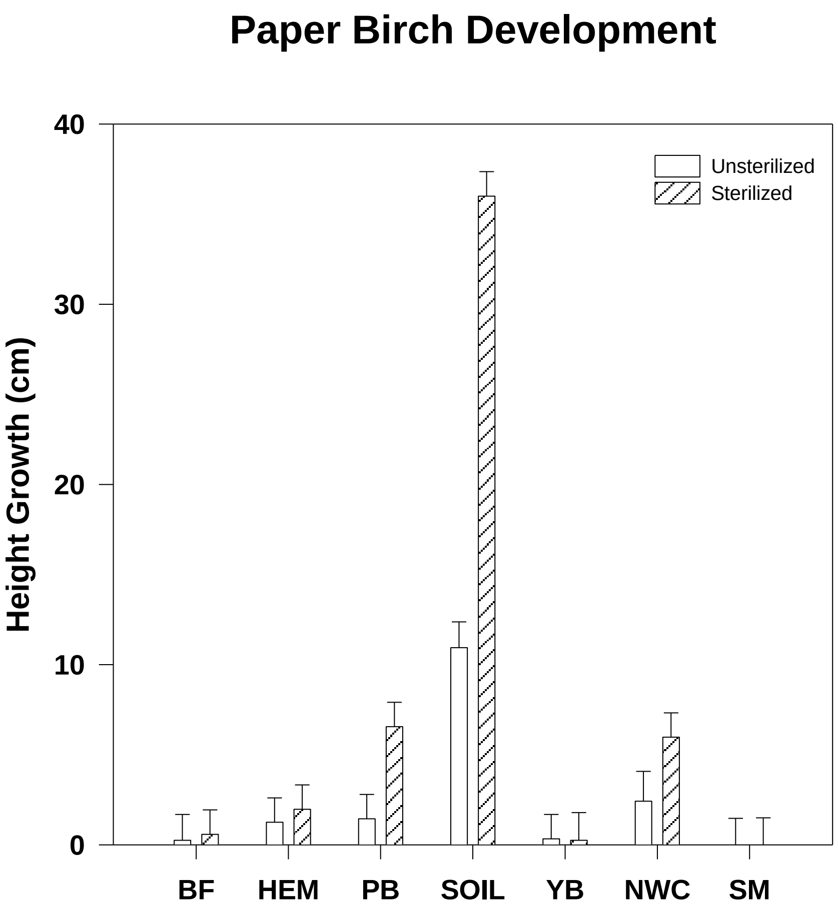
All samples transported back to MSU Tree Research Center

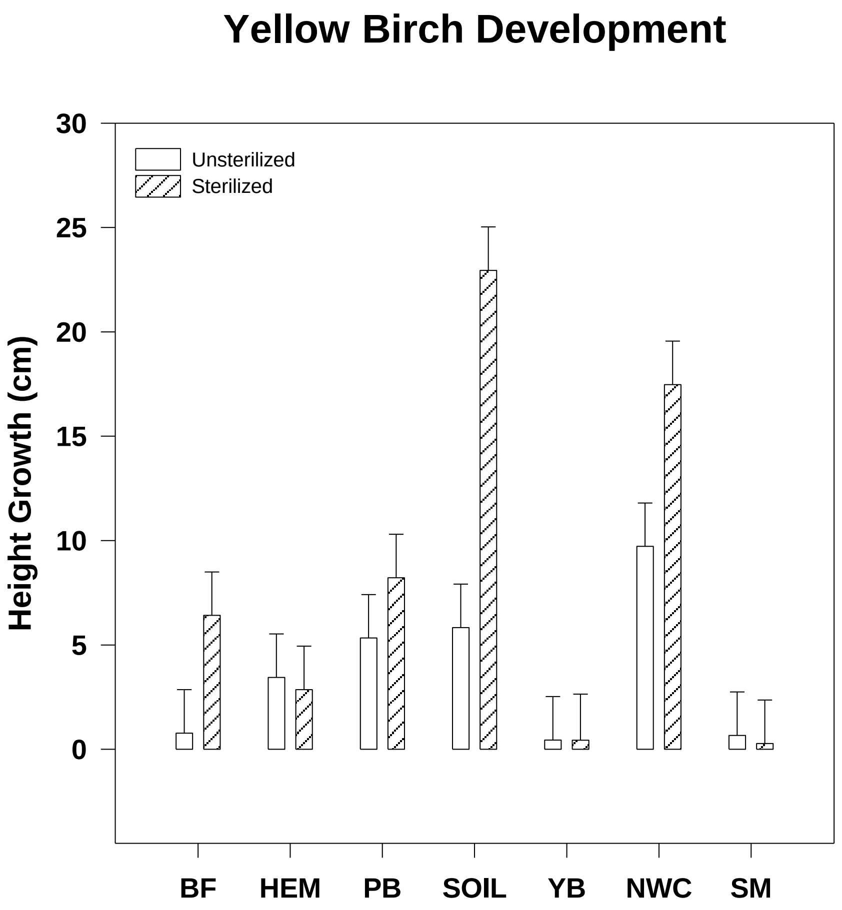
Potted plant experiment:
12tree species X 7 substrates X 2 treatments

Tree species: PB,YB,WP,RP,SM, RM,RO,HEM,WS,BF,WA,NWC

Substrates: CWD of PB,SM,YB,HEM,BF,NWC and Soil

Sterilization Treatments:
Gamma irradiated or not


Paper Birch Development
Height Growth (cm)
0
10
20
30
40
Unsterilized
Sterilized
BF
HEM
PB
SOIL
YB
NWC
SM


Yellow Birch Development
Height Growth (cm)
0
5
10
15
20
25
30
Unsterilized
Sterilized
BF
HEM
PB
SOIL
YB
NWC
SM

Acknowledgements

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U S
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