# Northern hardwood regeneration following selection harvests in the Western Upper Peninsula


**Michigan Chapter SAF Conference**

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**and James D. A. Millington**

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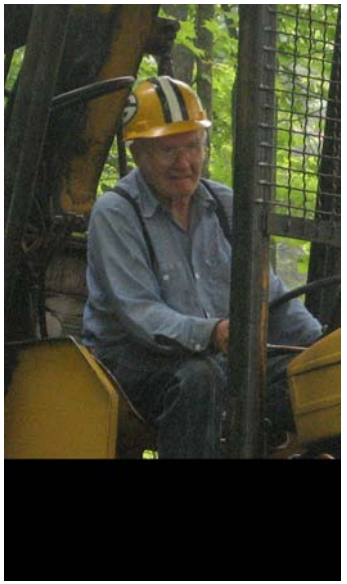
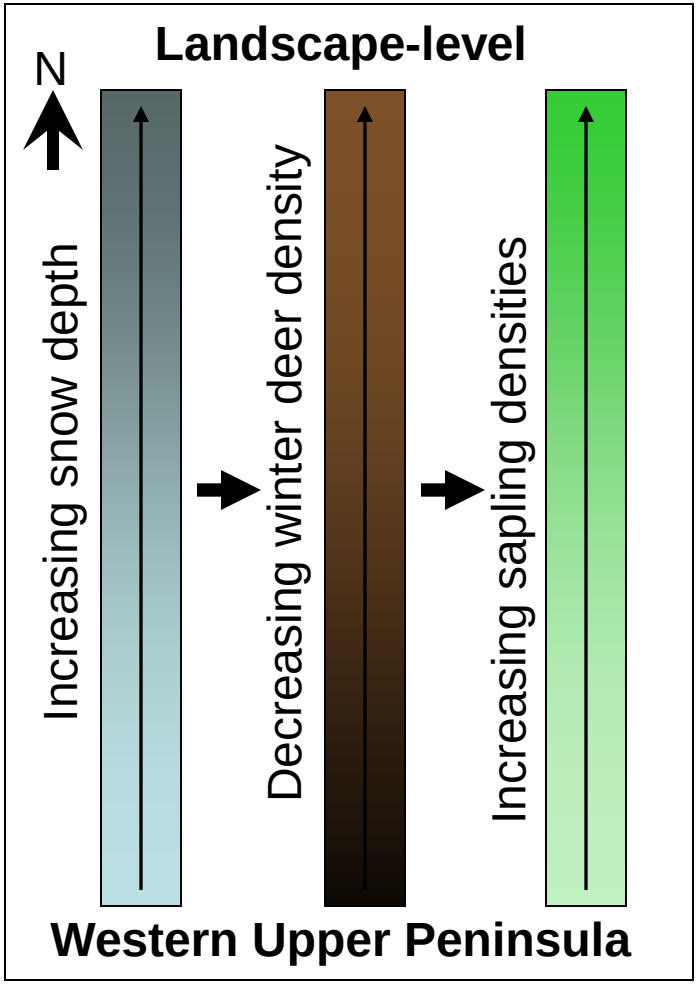
# Acknowledgements

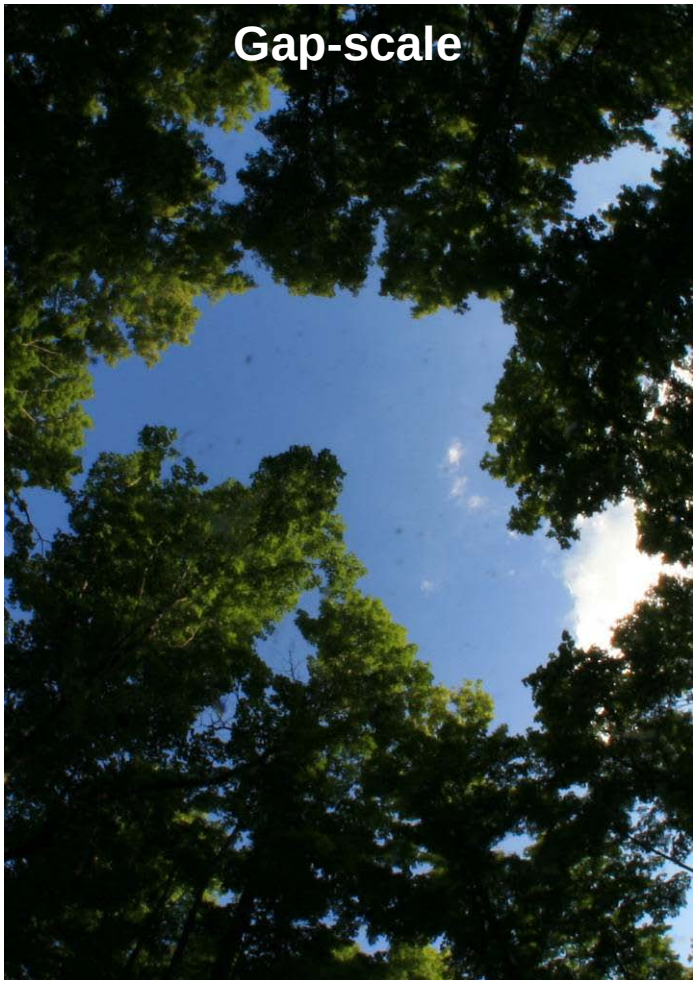


# Selection harvesting mimics the natural gap regeneration process

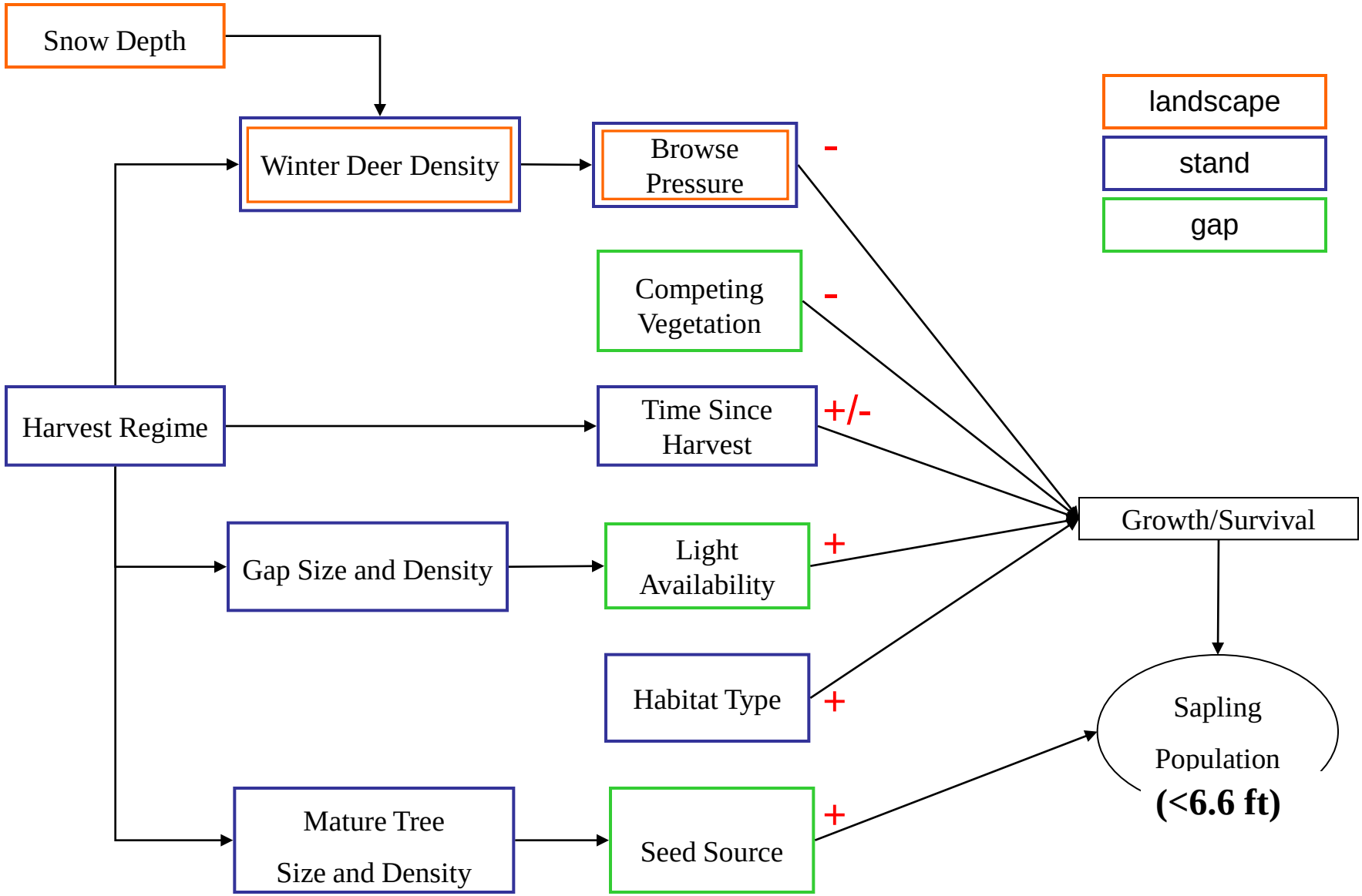
# Not all stands successfully regenerate

# What gap, stand and landscape-scale factors help explain variation and spatial patterns in northern hardwood regeneration?



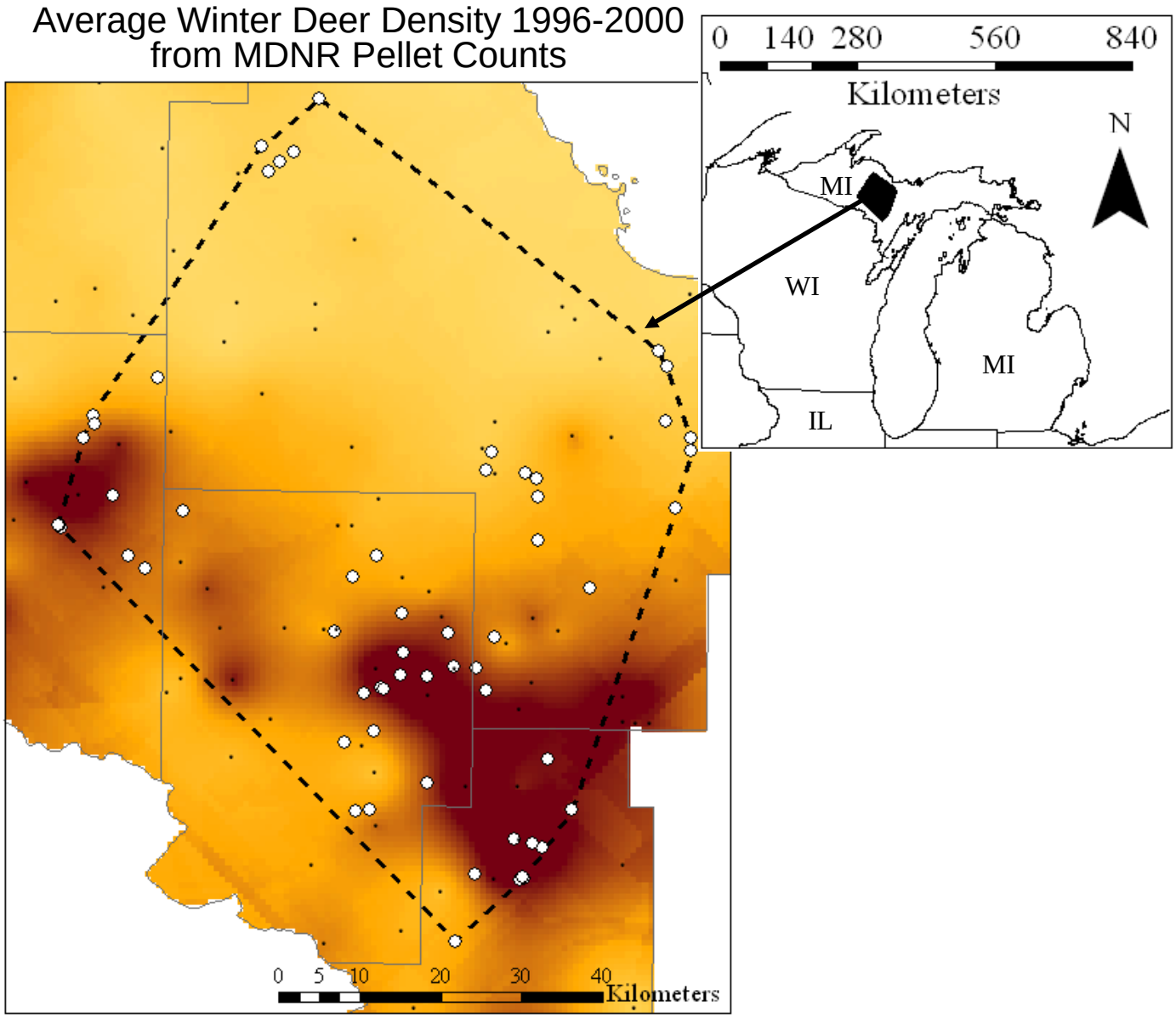



# Hypothesized factors affecting northern hardwood regeneration



# Methods

# Study Area

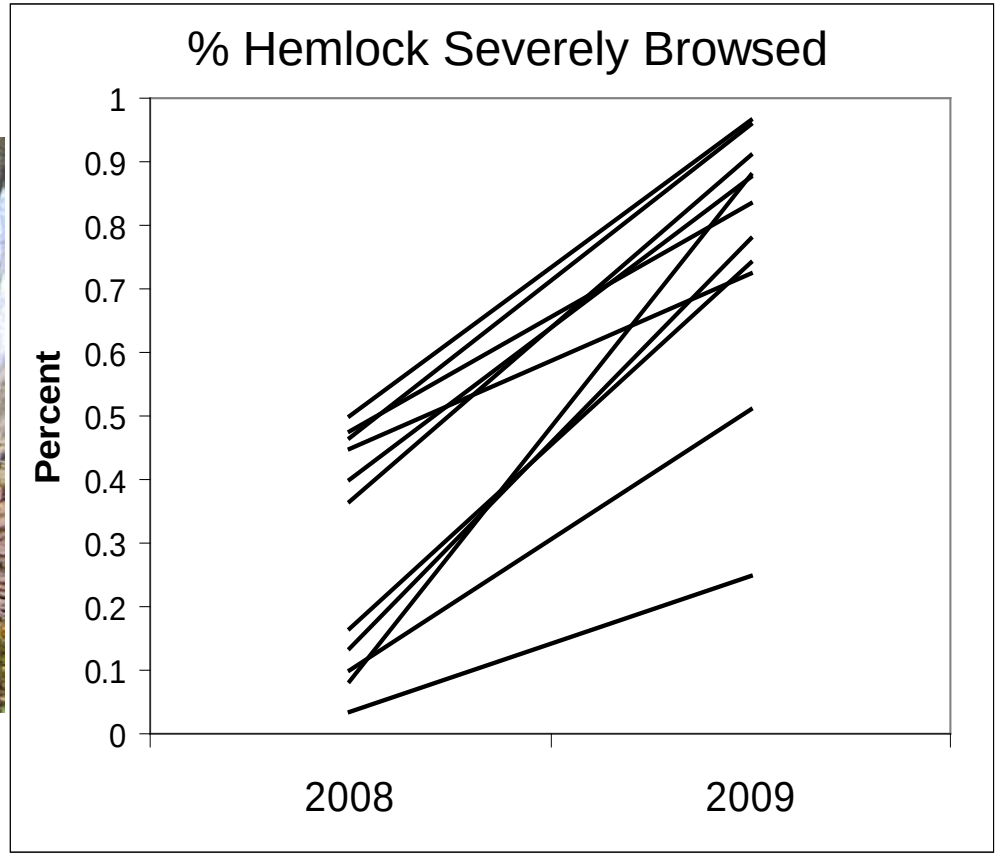

Average Winter Deer Density 1996-2000
from MDNR Pellet Counts
0 140 280 560 840
Kilometers
N
MI
WI
MI
IL
0 5 10 20 30 40
Kilometers
Legend
Average 1996-2000
Winter deer/mi2
High : 137
Low : 0

# Intense Browse Pressure Across Study Area

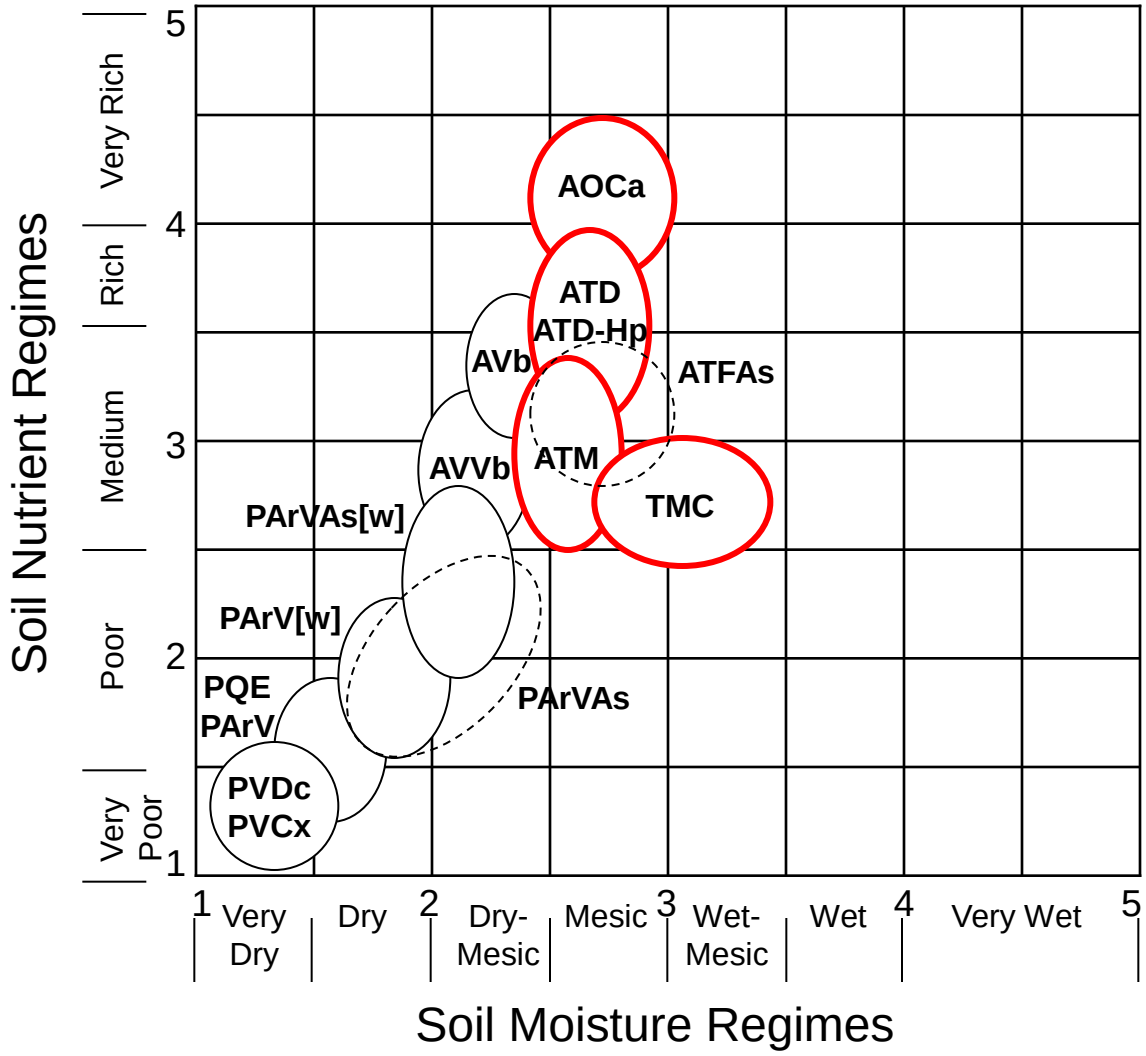

| 2008<br>34 sites | % Browsed | % Hemlock with Severe Browse |
|---|---|---|
| Spruce | 1.8 | |
| Pine | 29.5 | |
| Hemlock | 92.4 | 60.3 |

| 19 pine/ 11 hemlock sites | % Browsed | | % Hemlock with Severe Browse | |
|---|---|---|---|---|
| Year | 2008 | 2009 | 2008 | 2009 |
| Pine | 19.0 | 51.6 | | |
| Hemlock | 81.7 | 95.6 | 28.7 | 75.9 |

# Cumulative browsing across years at sites with lower 2008 hemlock browsing




# Habitat type soil moisture and nutrient regimes in Western U.P., Michigan




Recreated from Burger and Kotar 2003

# Results

- Characterization of regeneration
- Gap and stand-level variables explaining variation
- Spatial patterns in regeneration
- Landscape-level variables explaining variation

# Sugar maple and ironwood dominated regeneration layer

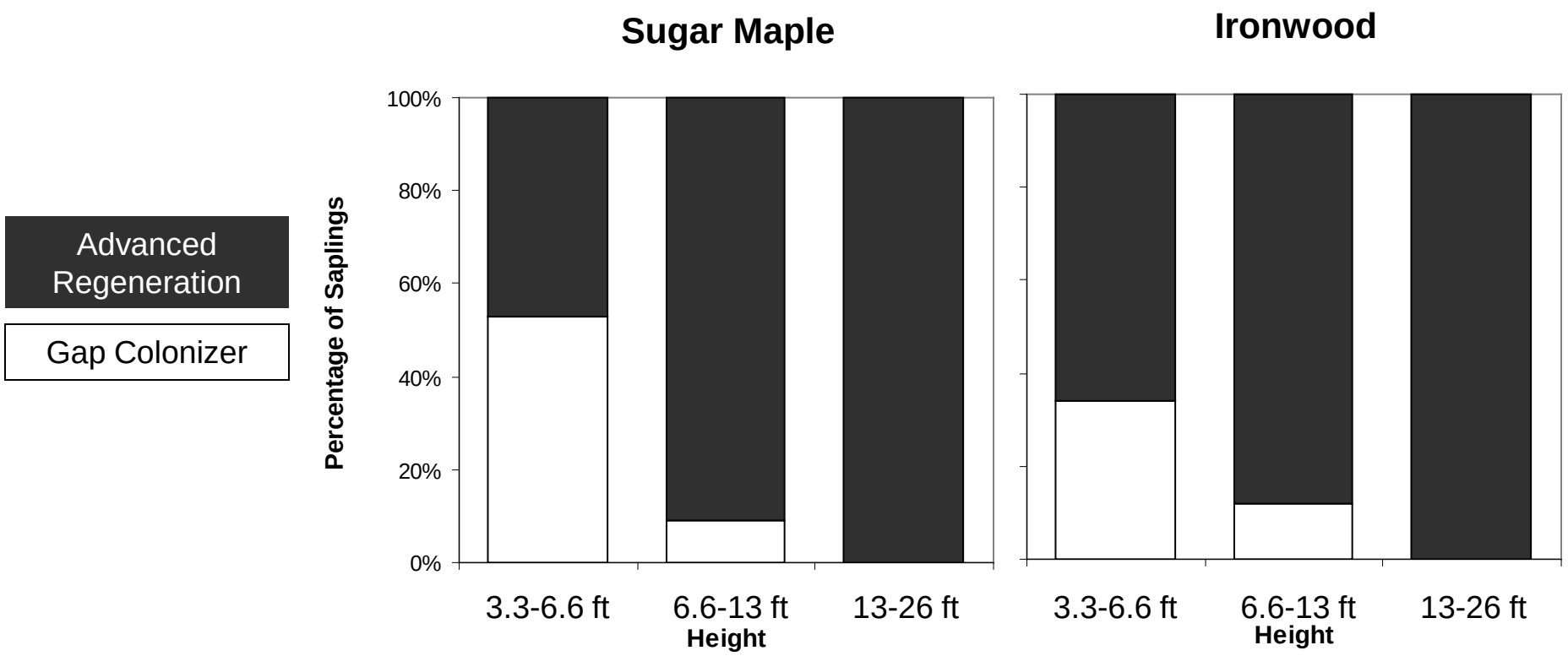
Sapling composition per acre

| Species 3.3-23 ft | Ave stems (range) | Stdev | Occurrence (%) |
|---|---|---|---|
| Sugar maple | 1025 (0-12,981) | 2339 | 52 |
| Ironwood | 289 (0-4,940) | 675 | 57 |
| White ash | 184 (0-9,802) | 959 | 19 |
| Red maple | 131 (0-7,857) | 562 | 17 |
| Black cherry | 79 (0-2,470) | 223 | 32 |
| Balsam fir | 26 (0-1,104) | 95 | 10 |
| All species | 1734 (0-15,110) | 2859 | 88 |

Uncommon species in sapling layer (1-5% occurrence):
paper birch, yellow birch, beech, black ash, larch, black spruce, quaking aspen, bigtooth aspen, balsam poplar, red oak, basswood and elm

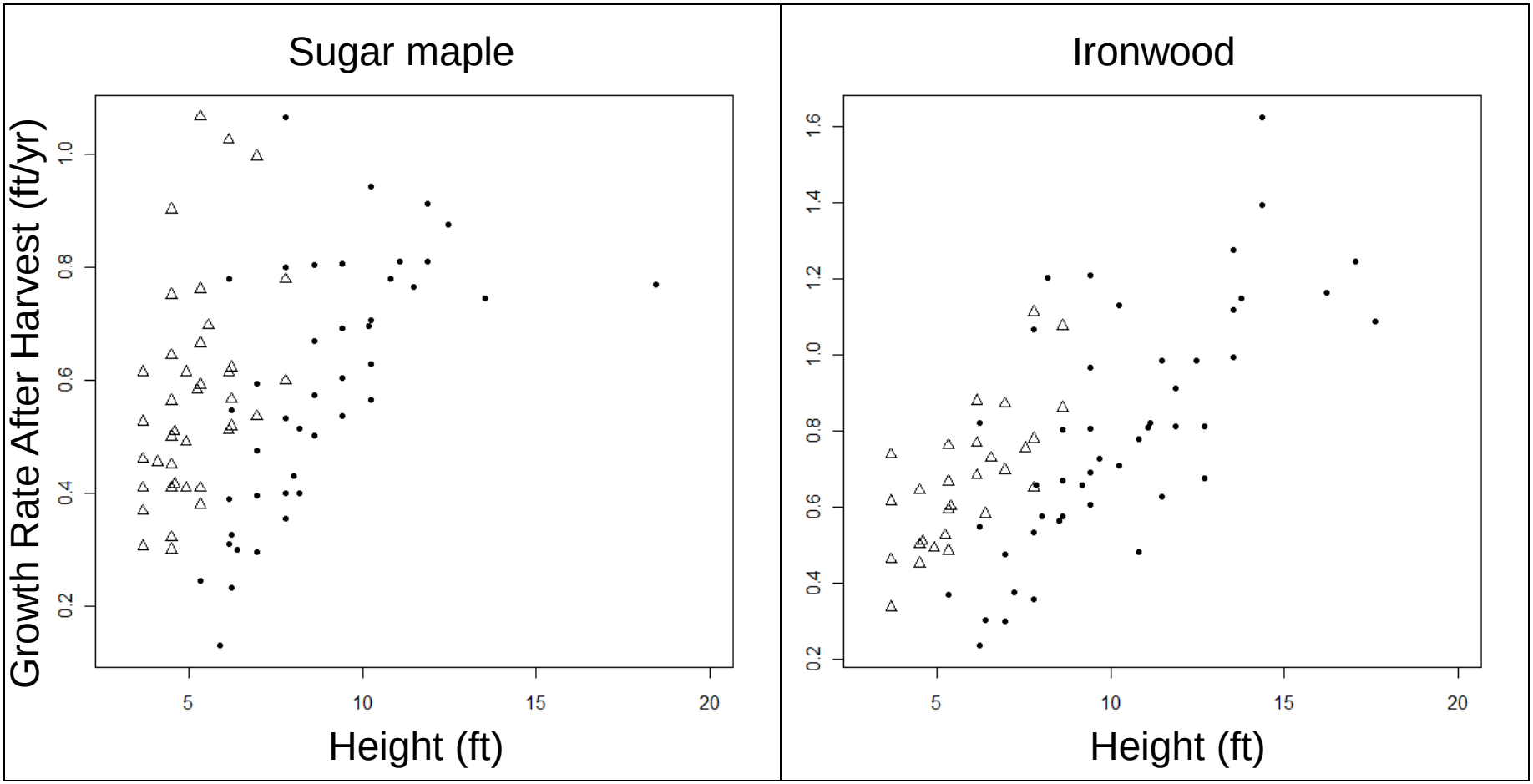
Mature trees at 6 sites, 6 seedlings, 21 saplings

# Importance of advanced regeneration




| | Sugar maple | Ironwood |
|---|---|---|
| Tallest gap colonizer | 9 ft | 8.2 ft |
| | Advanced Regeneration > 13 ft | |
| Ave. age at gap formation | 29 | 17 |
| Range of ages at gap formation | 5-87 | 1-42 |

# Advanced regeneration vs gap colonizers growth rates following harvest



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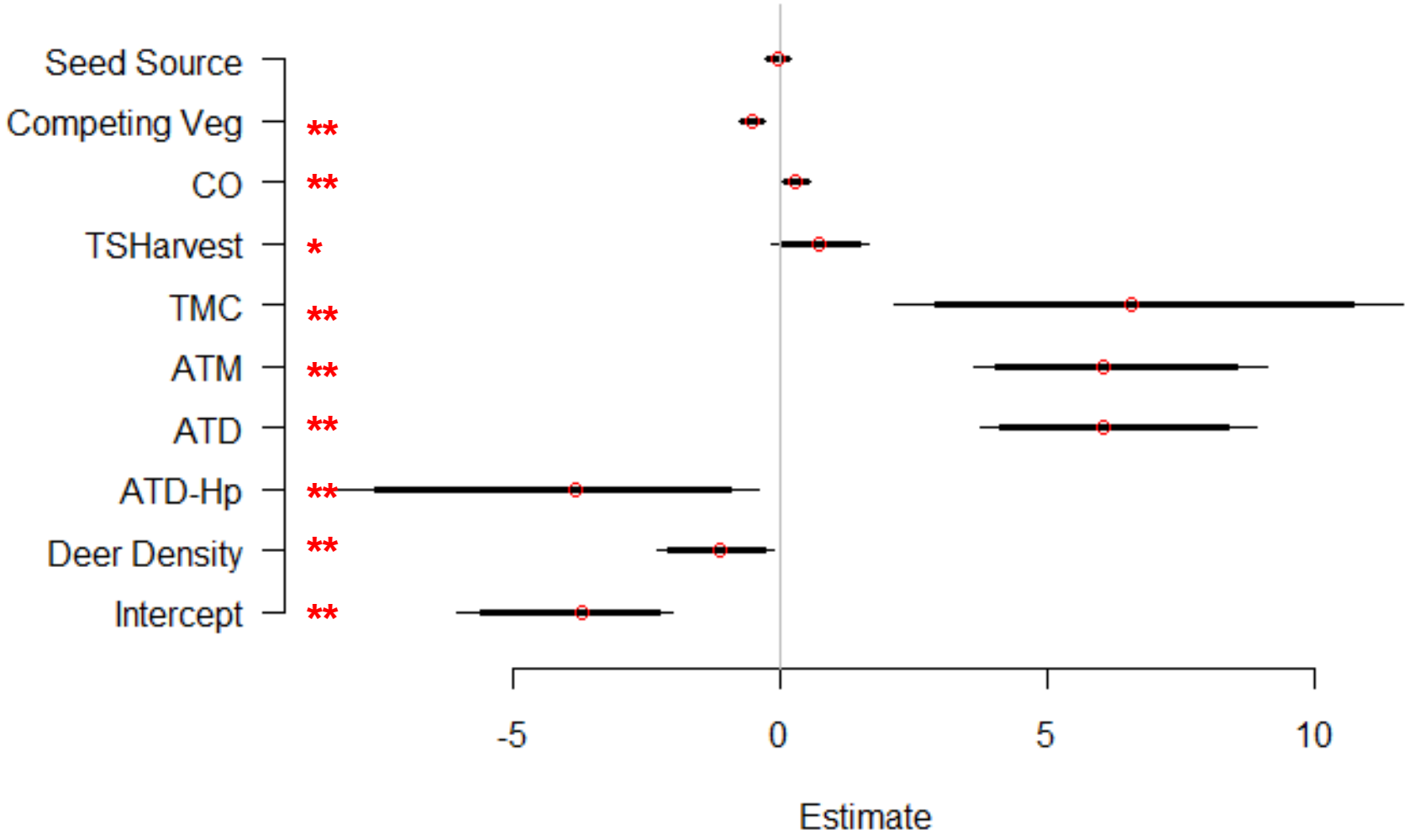
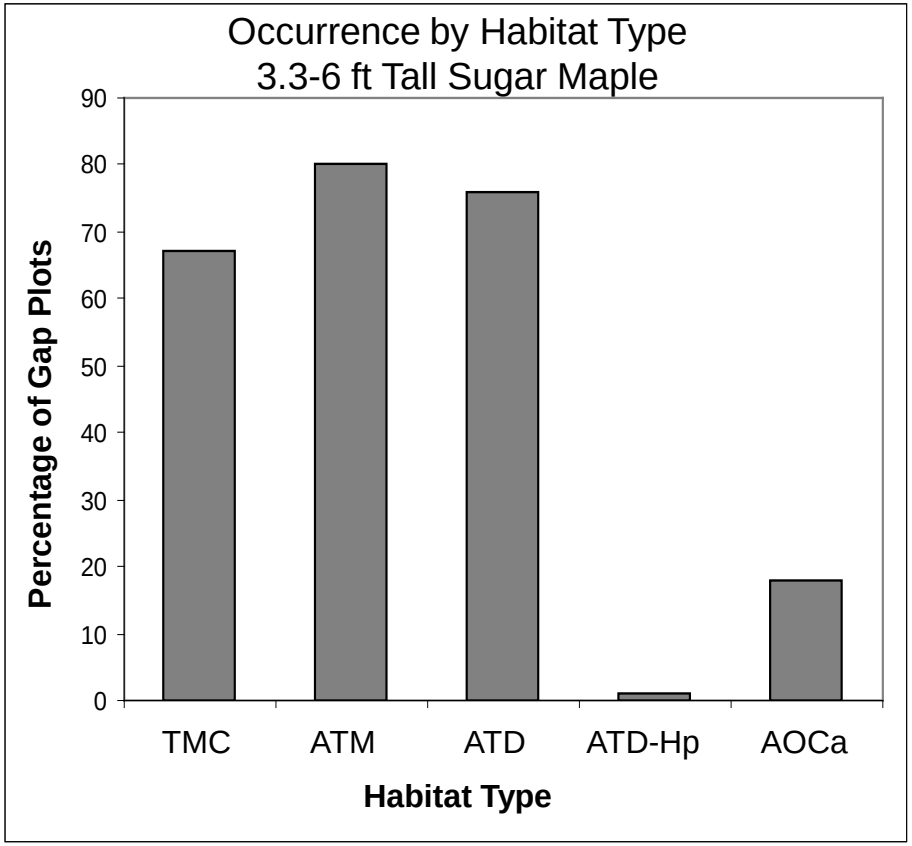
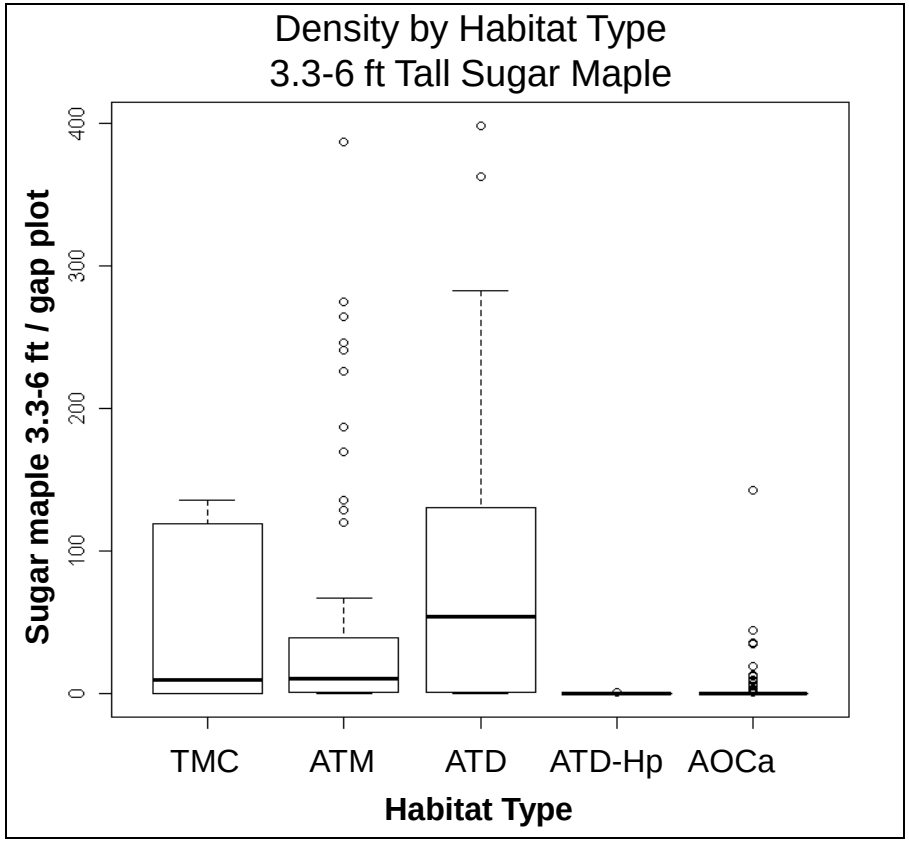
# Sugar maple regeneration (3.3-6.6 ft) is affected by both gap- and stand-level variables



# Sugar maple sapling occurrence and abundance varies by Habitat Type

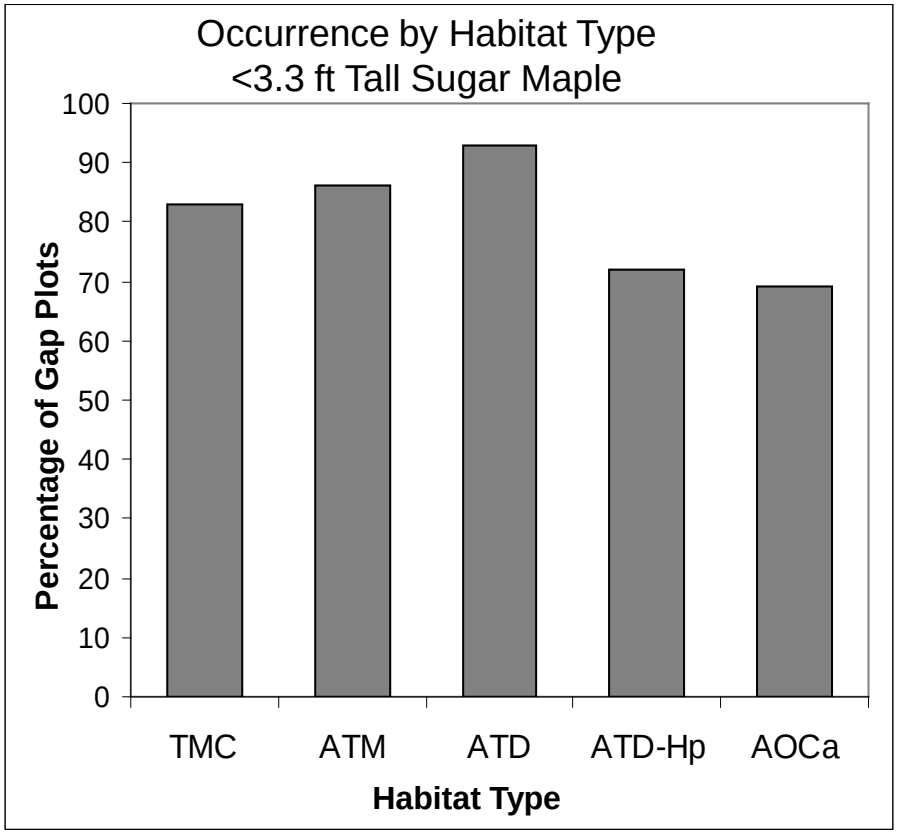


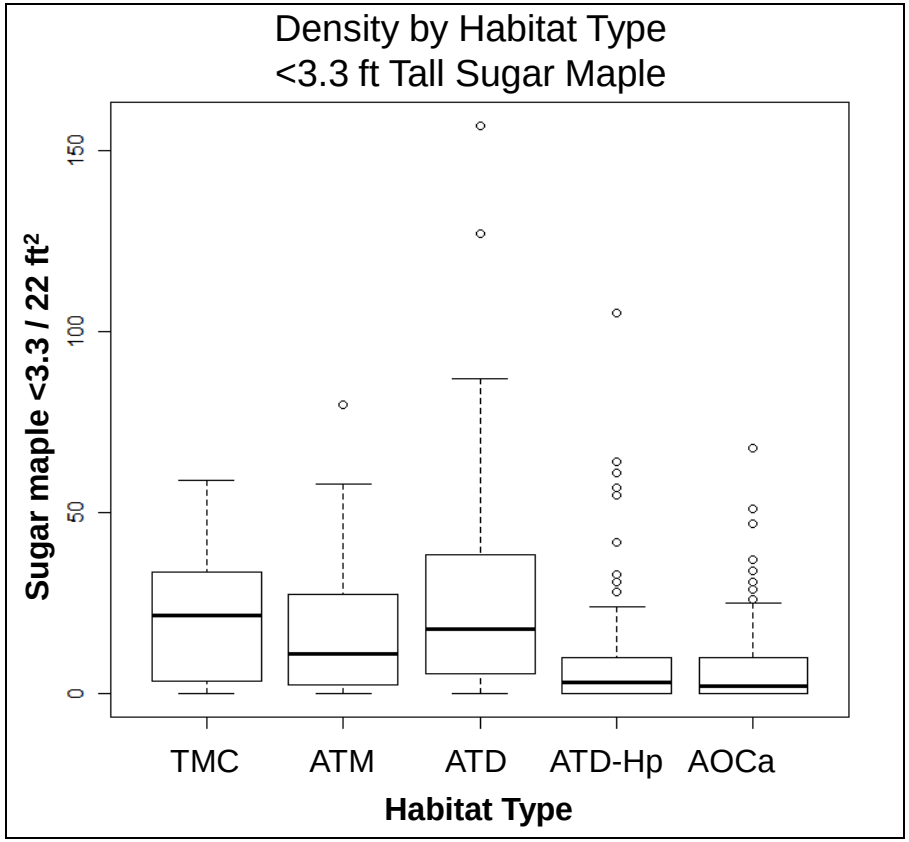




Richer soil nutrient regime

Richer soil nutrient regime

# Sugar maple seedling occurrence and abundance varies by Habitat Type, but not as much

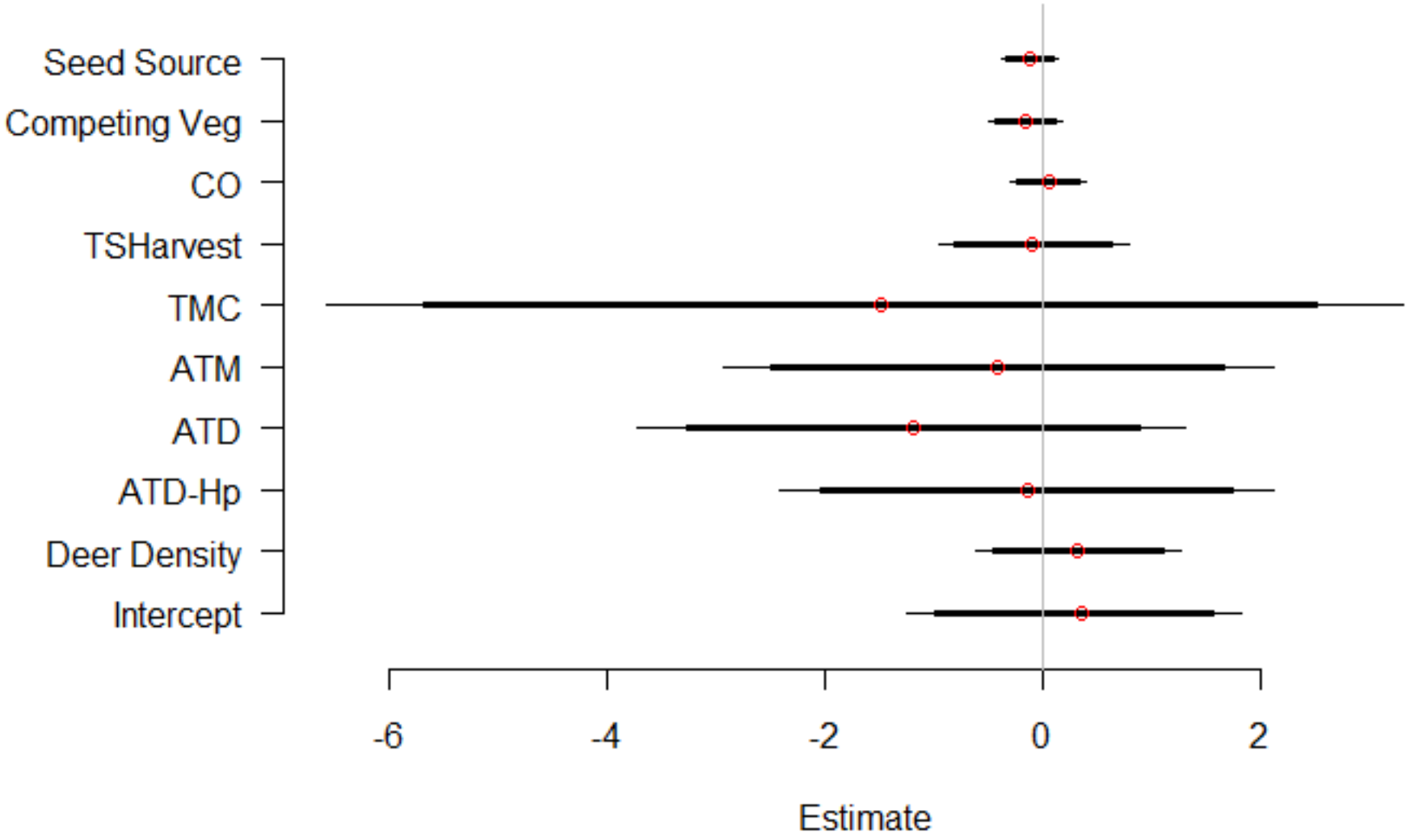



Richer soil nutrient regime

Richer soil nutrient regime

# Ironwood appears unresponsive to measured gap- and stand-level variables



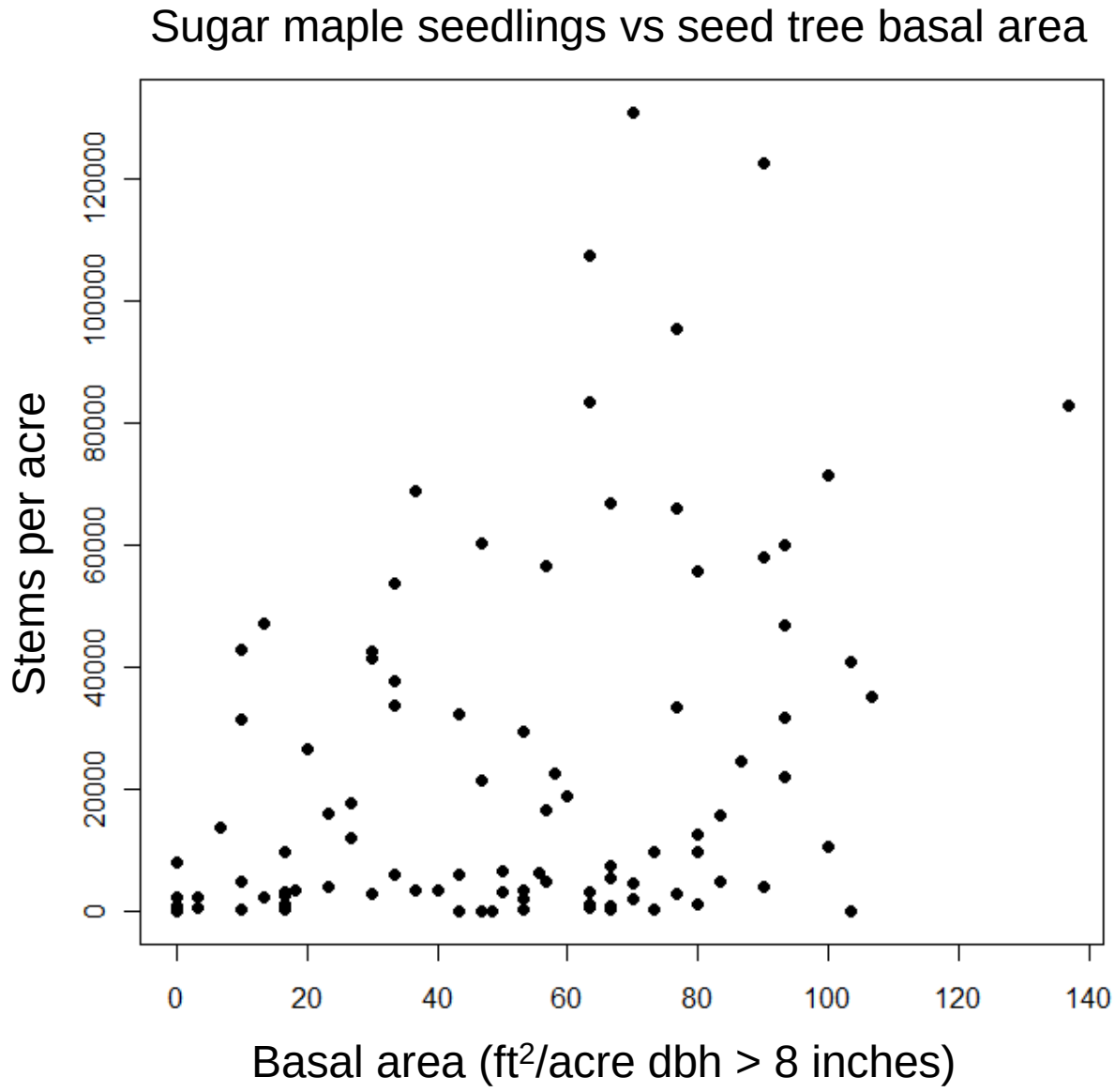
# Evidence of seed source limitation at the stand scale in managed forests

Basal area of mature trees with dbh > 2 inch ironwood, > 8 inch other

| Species (n) | BA | 2002 | 2003 | BA:2002 | BA:2003 | $r^2$ |
|---|---|---|---|---|---|---|
| Sugar maple (89) | + | - | - | + | + | .234 |
| Ironwood (64) | - | + | + | + | + | .405 |
| Red maple (54) | + | - | - | - | + | .541 |
| White ash (37) | - | + | + | + | + | .235 |

p<-0.001

# Evidence of seed source limitation at the stand scale in managed forests



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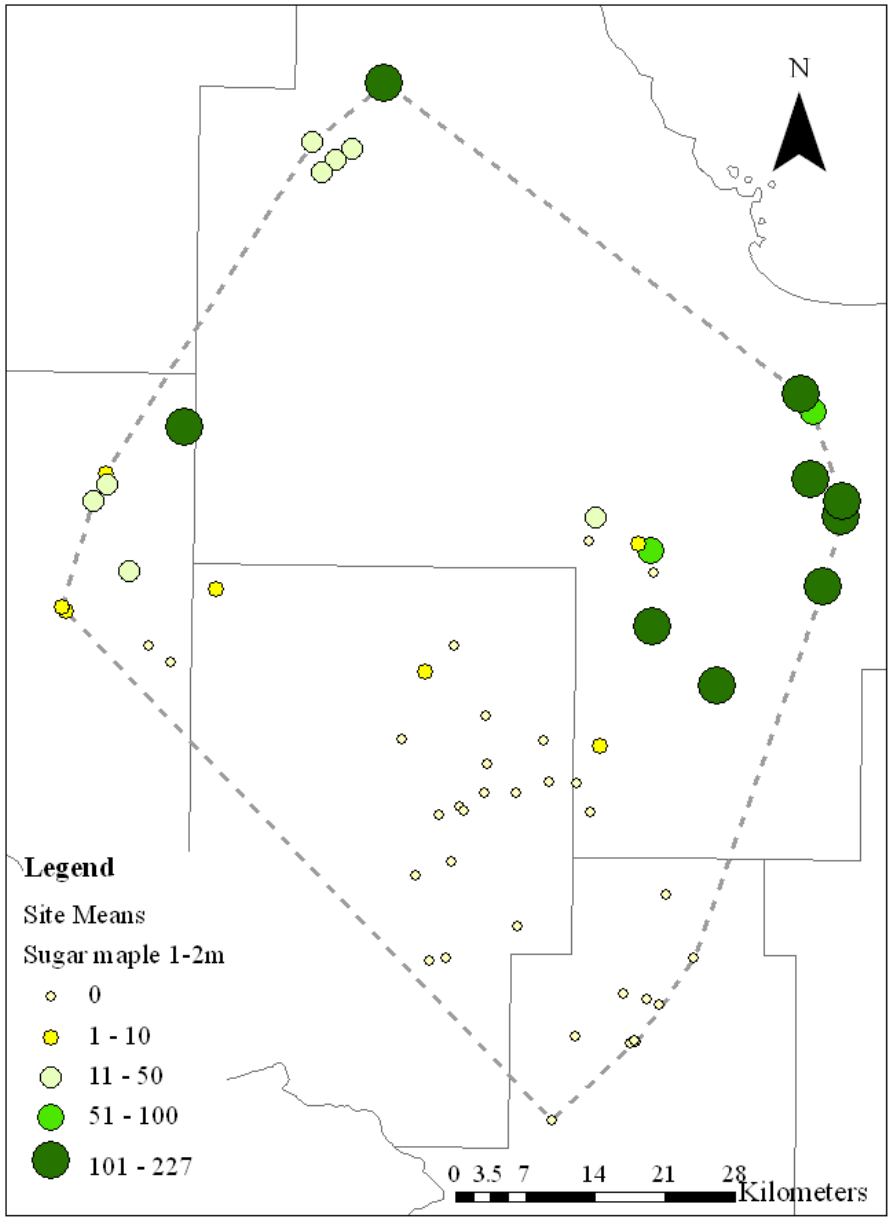
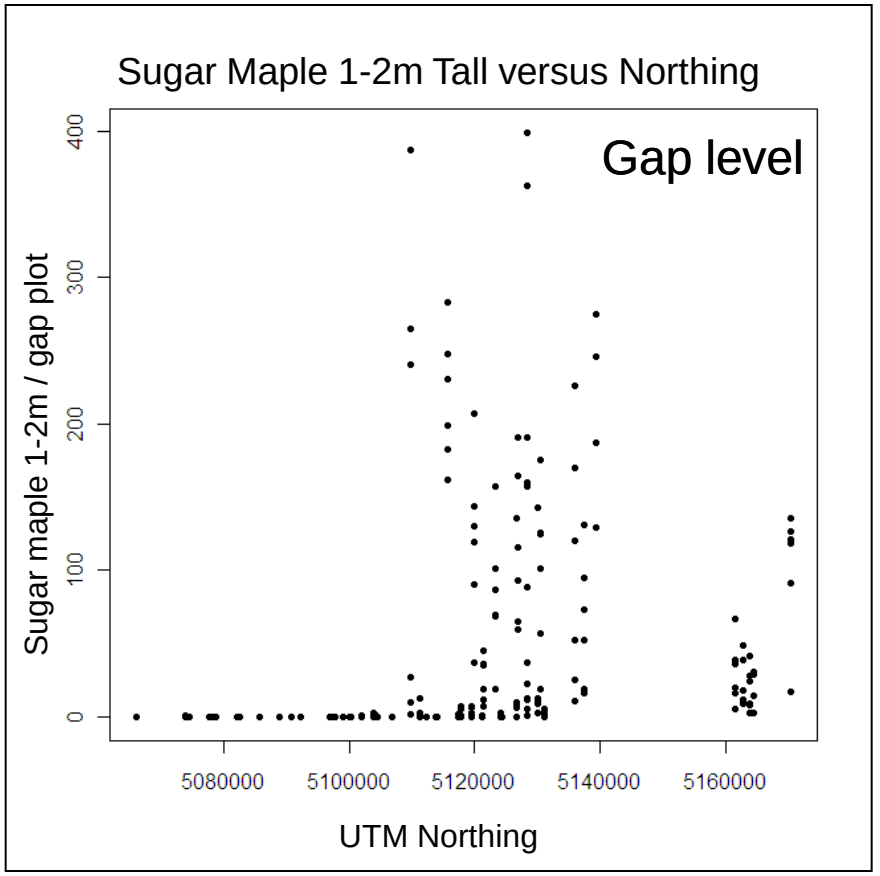
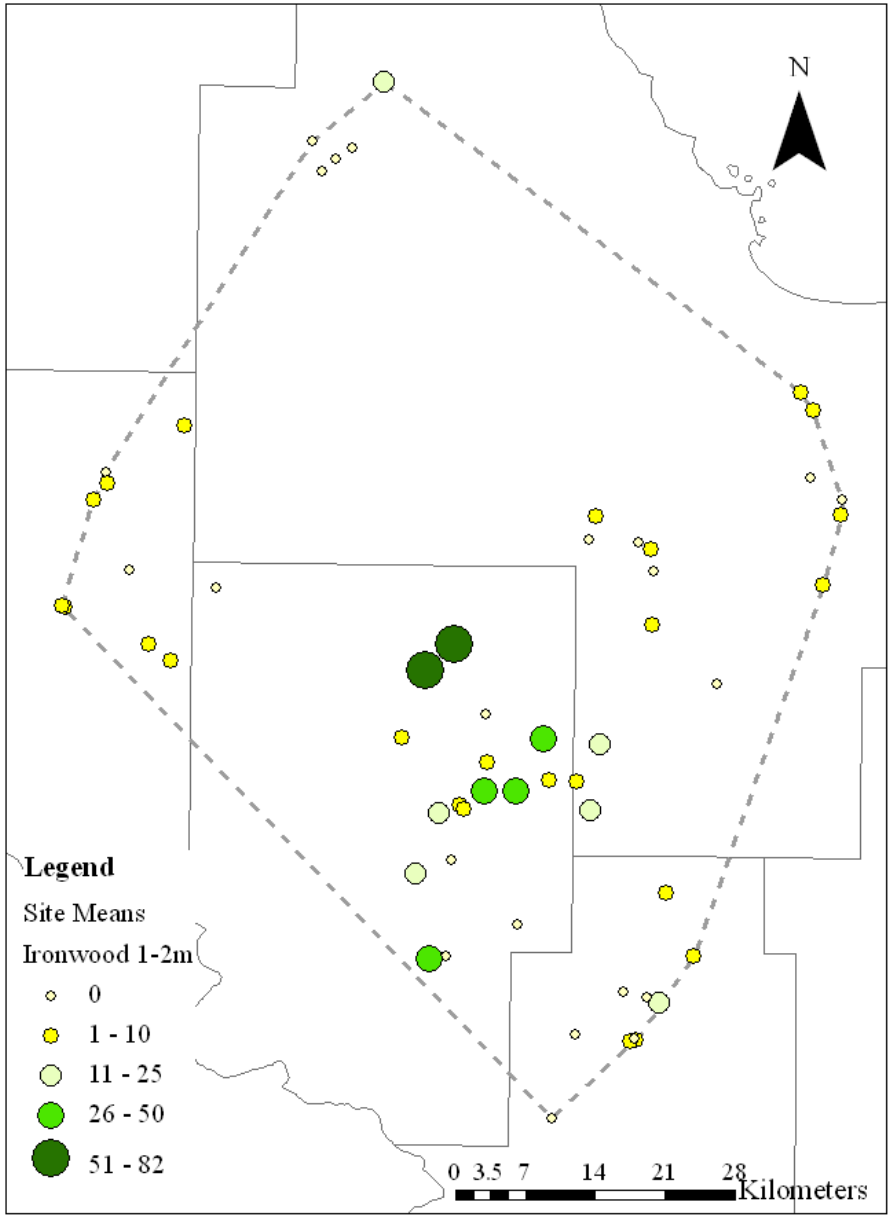
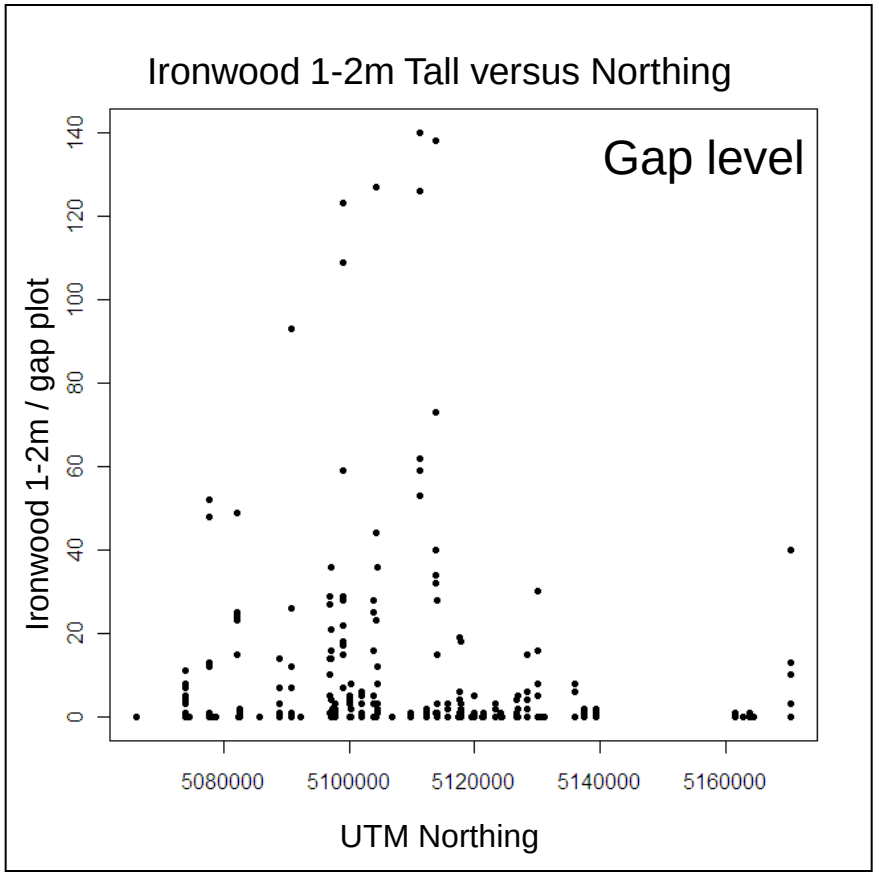
# Site average gap densities
# 1-2 m sugar maple saplings



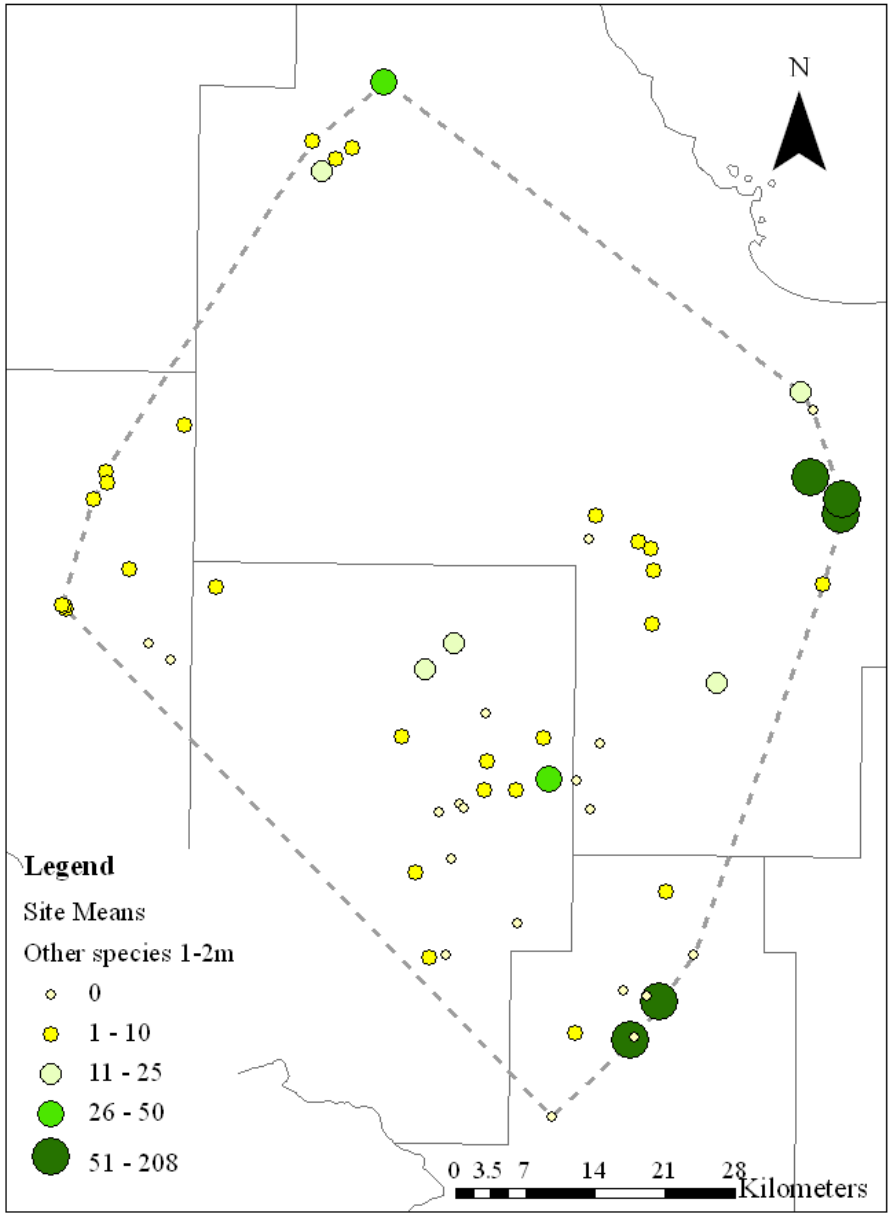



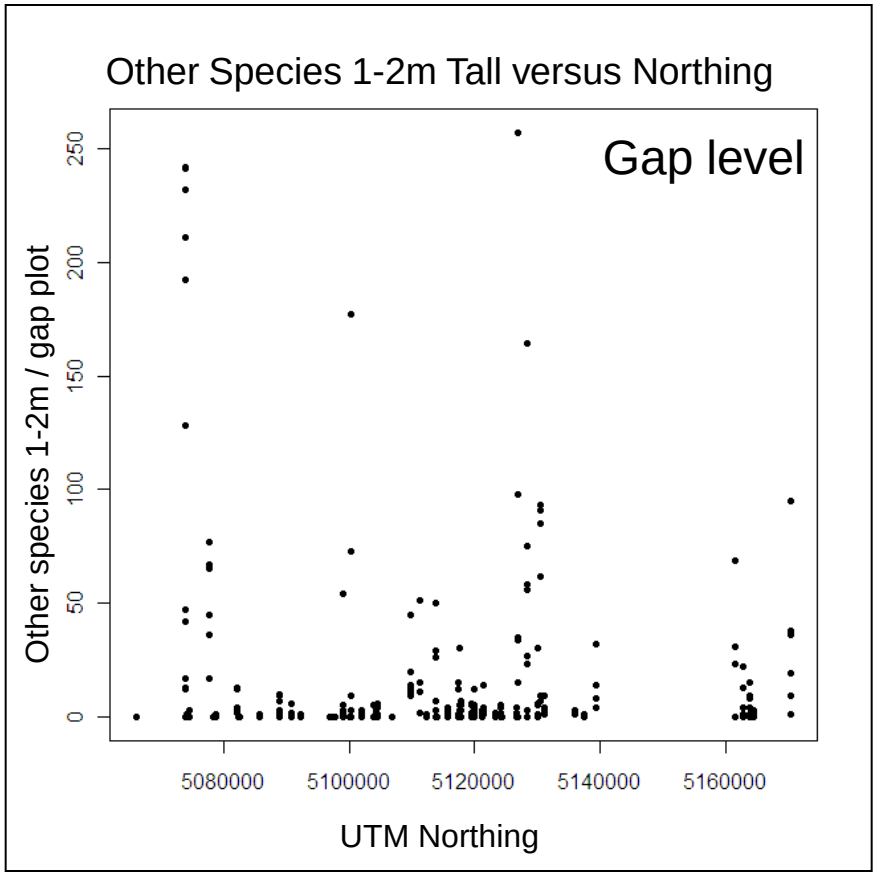
# Site average gap densities
# 1-2 m ironwood saplings



# Site average gap densities
# 1-2 m other species saplings



# Results

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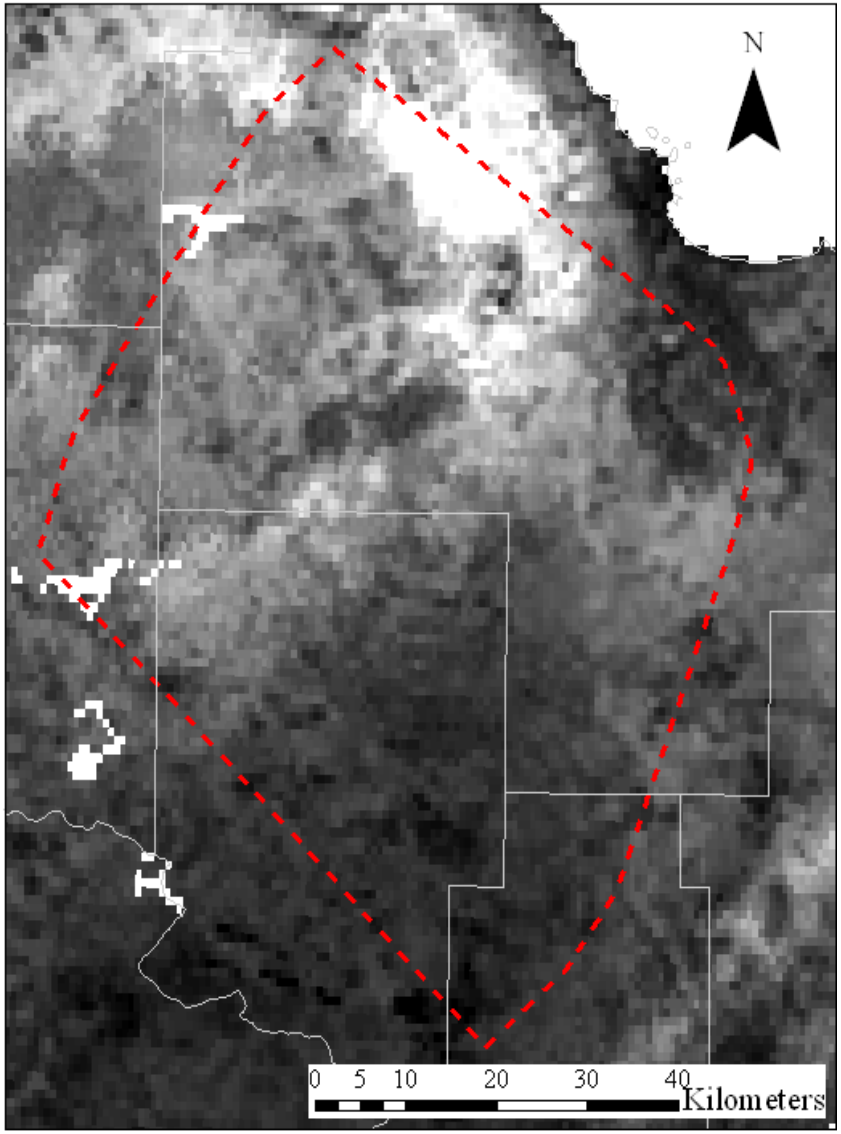
# Snow depth varies generally N-S

Average Snow Depth
November 2007 to April 2008




**Legend**

Snow depth (inch)

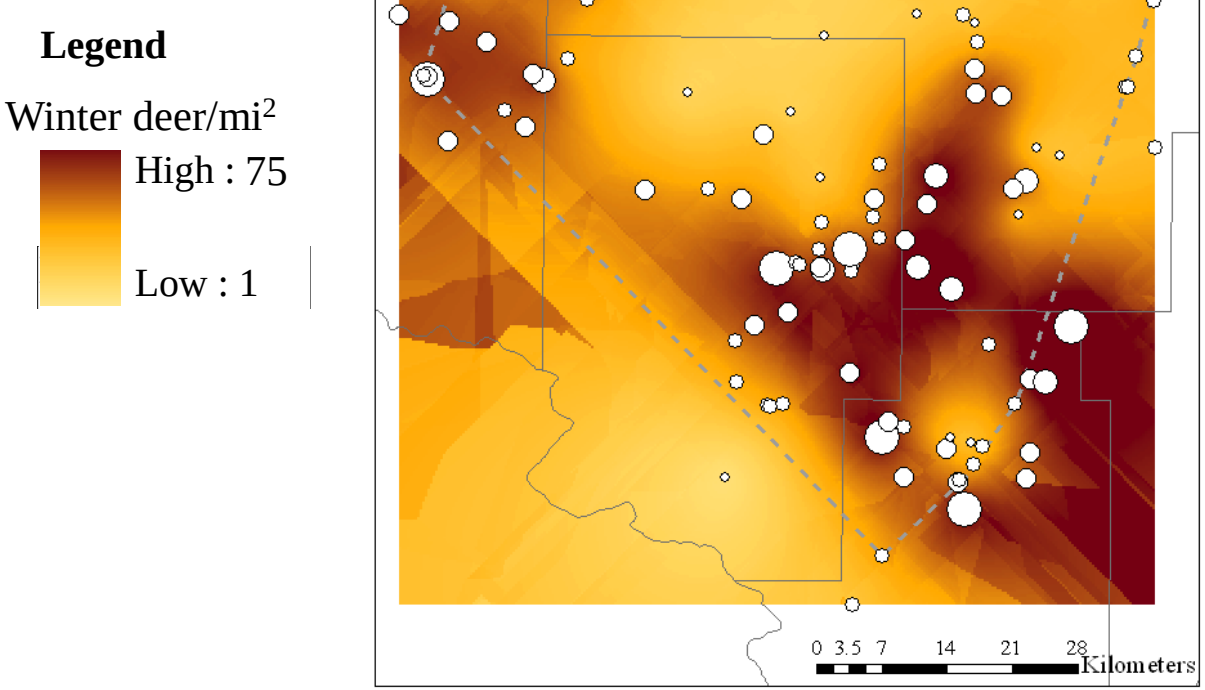
High : 26

Low : 2

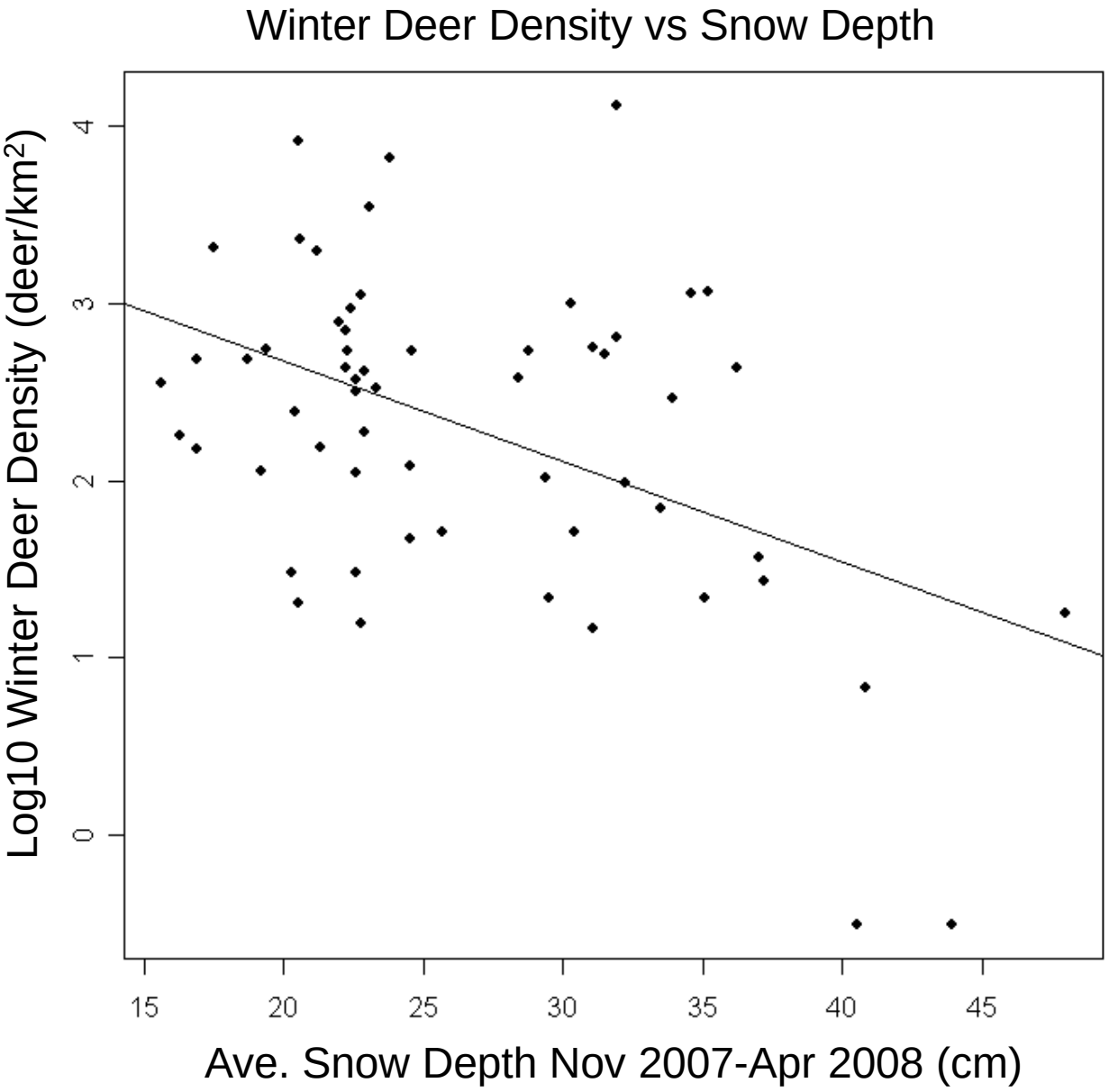
data source: SNODAS, NSIDC

# Deer density distribution displays regional variation

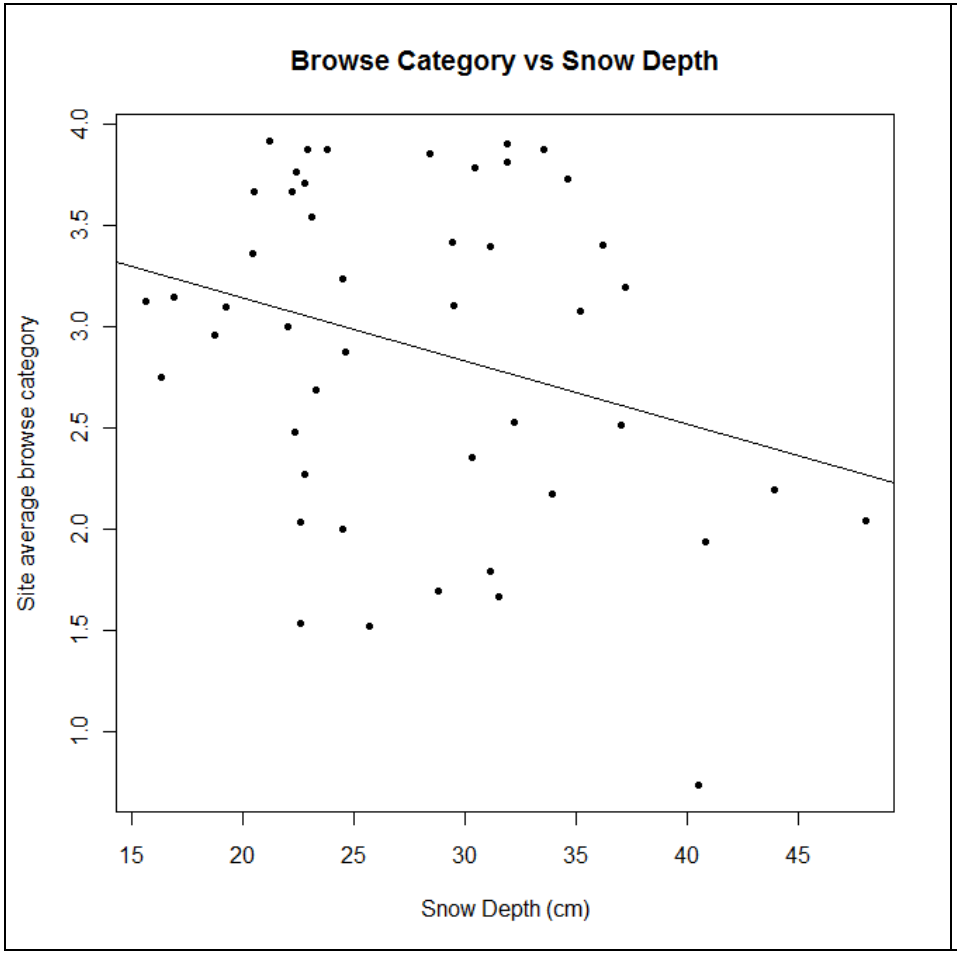
Winter Deer Densities Nov 2007-Apr 2008
(deer/mi$^2$) Fecal Pellet Method

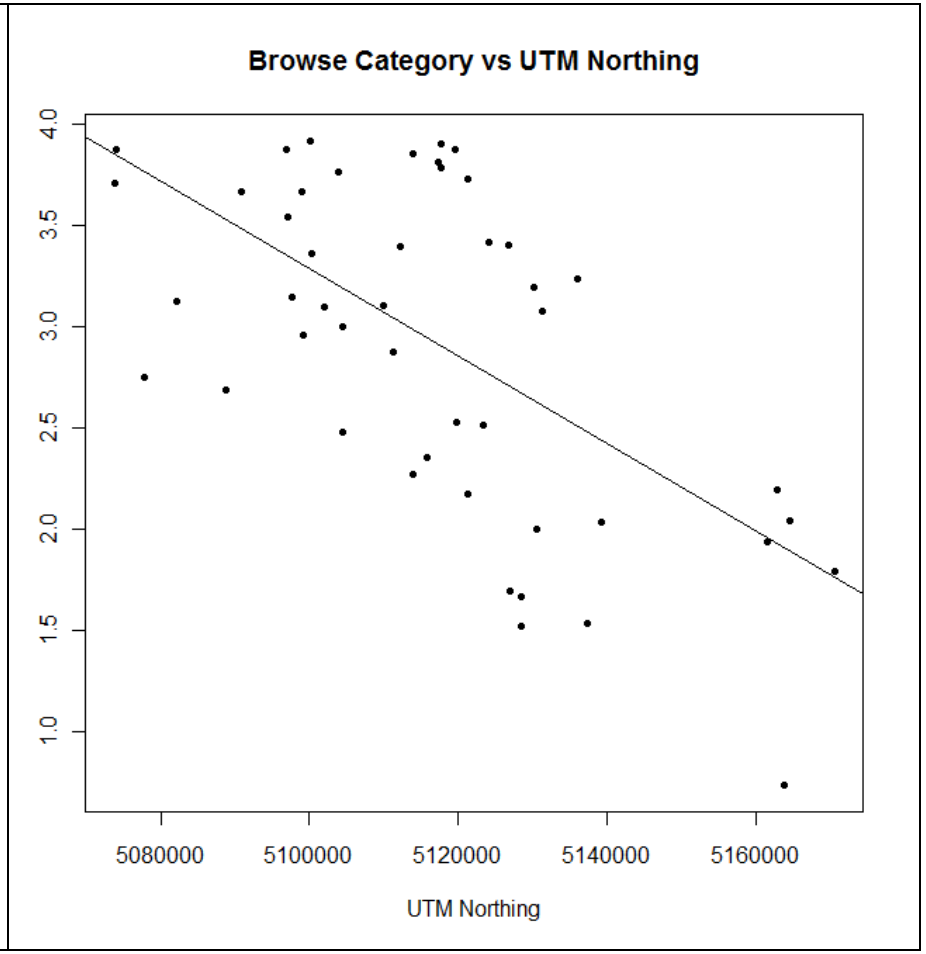


# Deer density decreases with snow depth

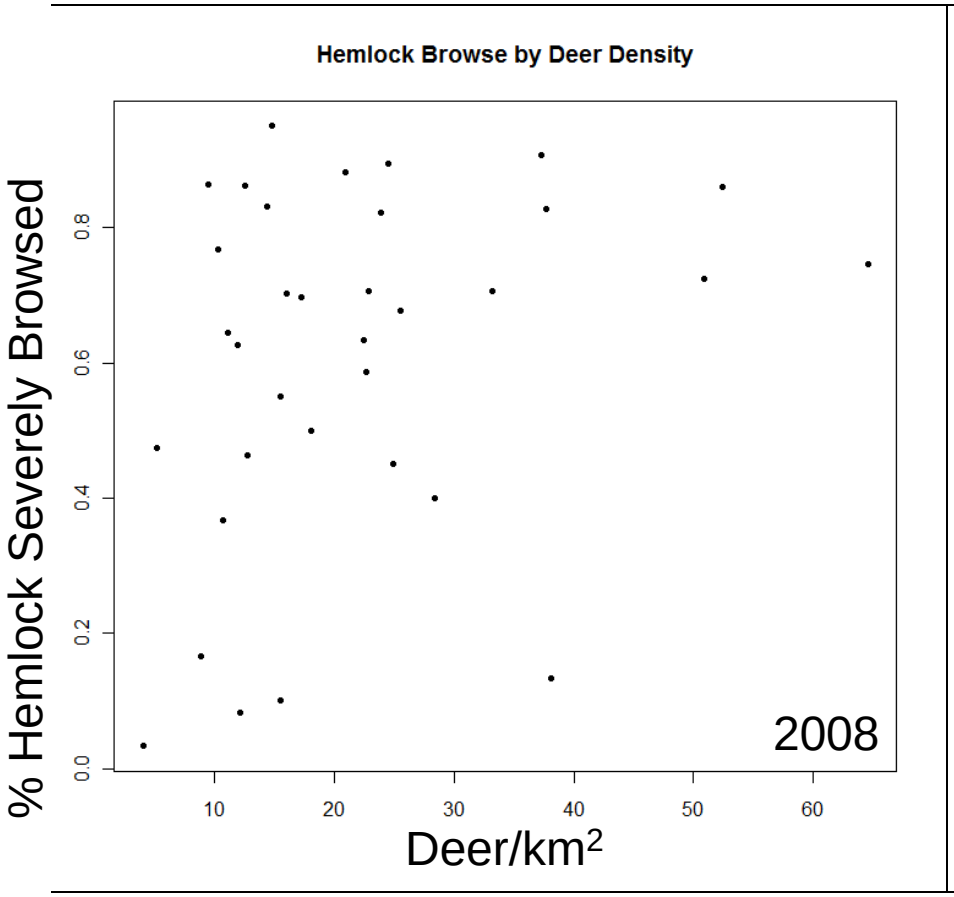


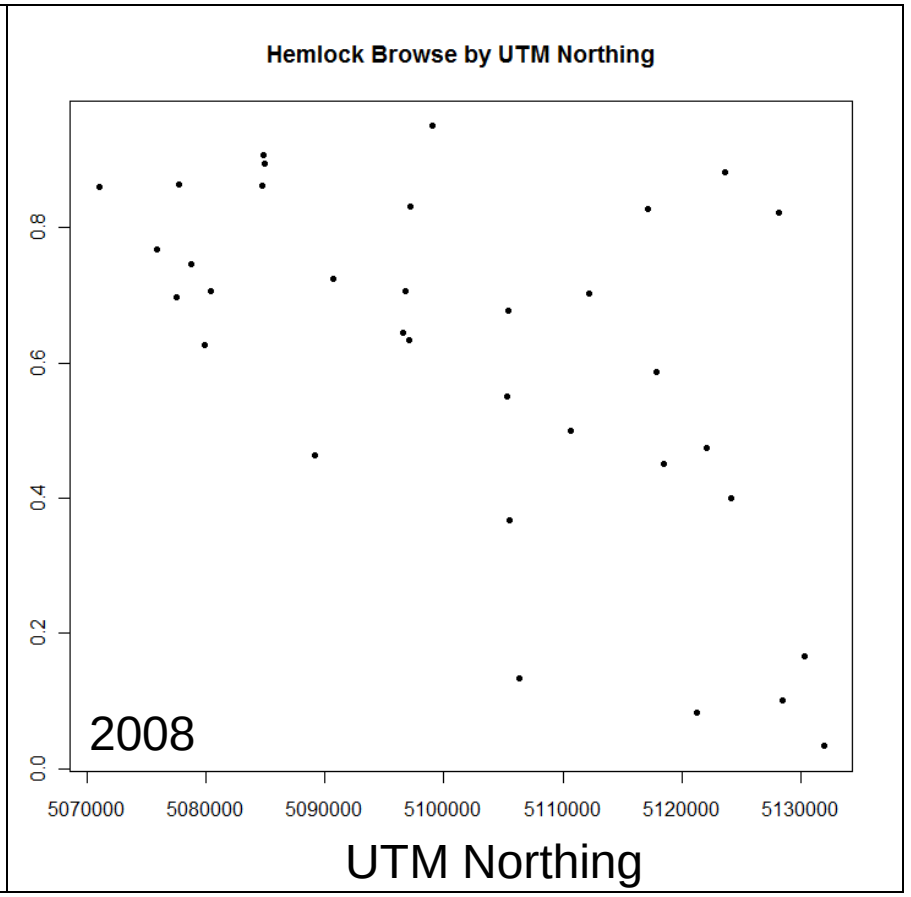
# Browse index decreases with snow depth



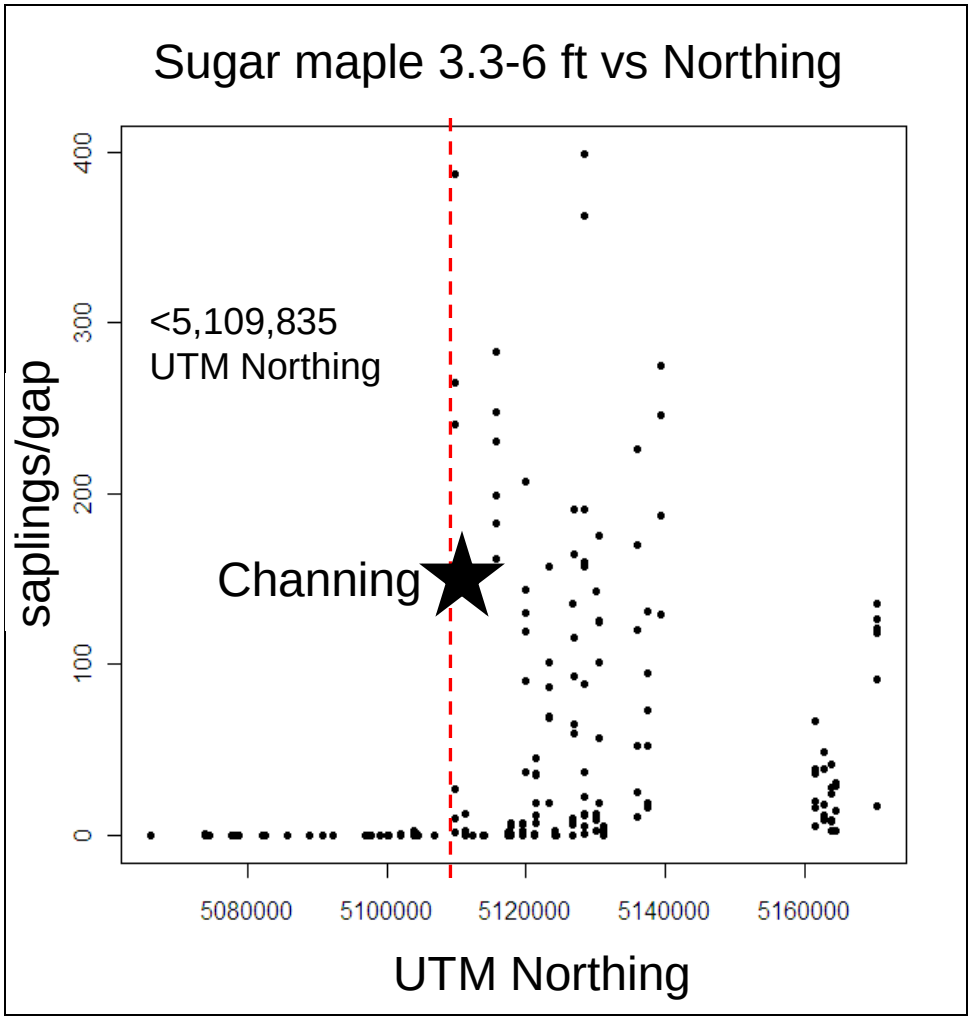



# Browsing on planted hemlock decreases with deer density and latitude



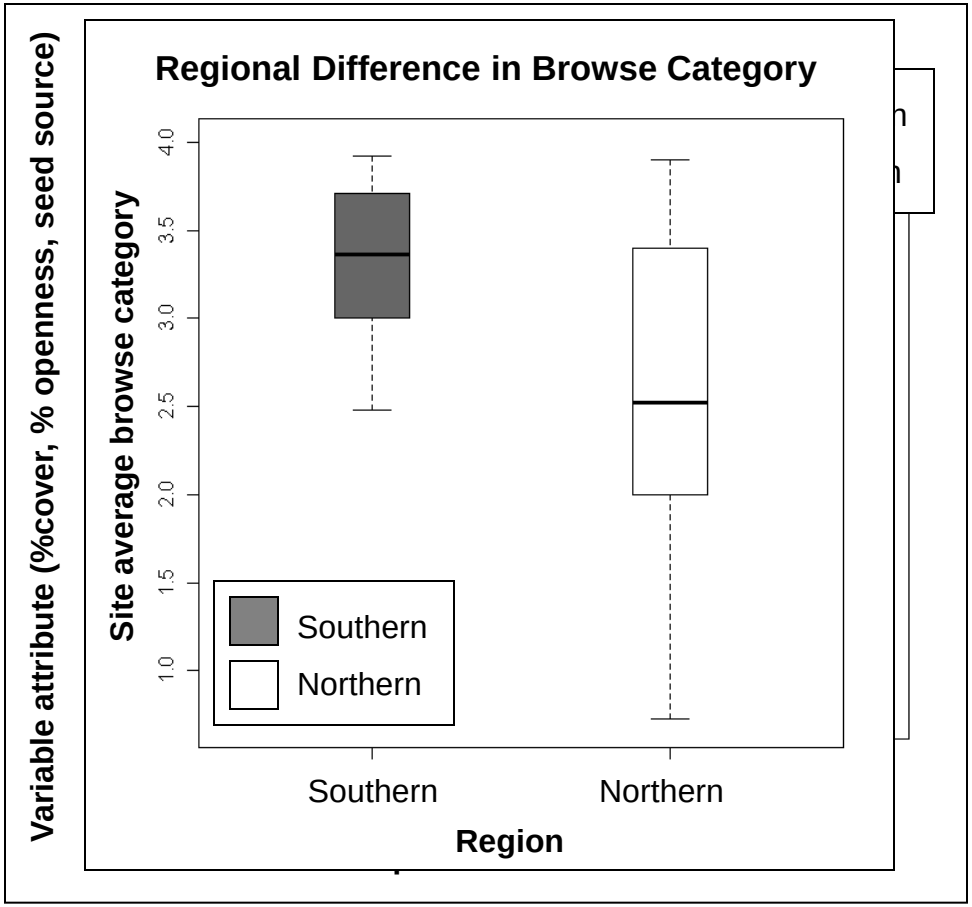
# Comparing gap- and site-level variables between southern and northern regions

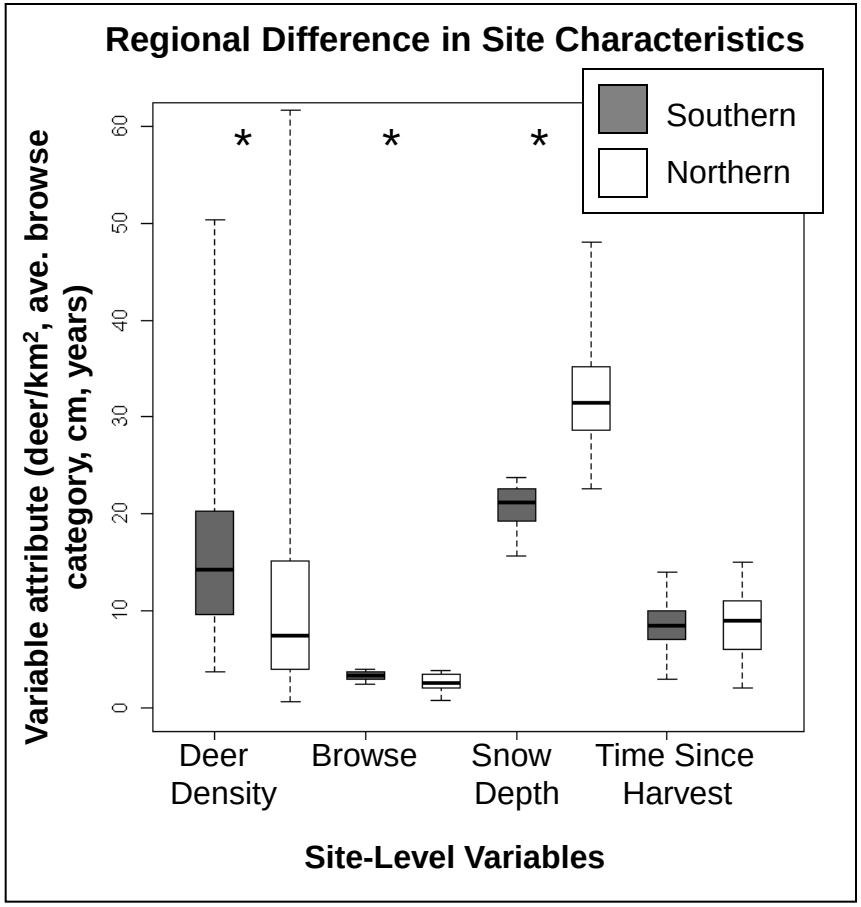



Southern Region
n= 163 gaps, 28 sites

Northern Region
n= 184 gaps, 31 sites

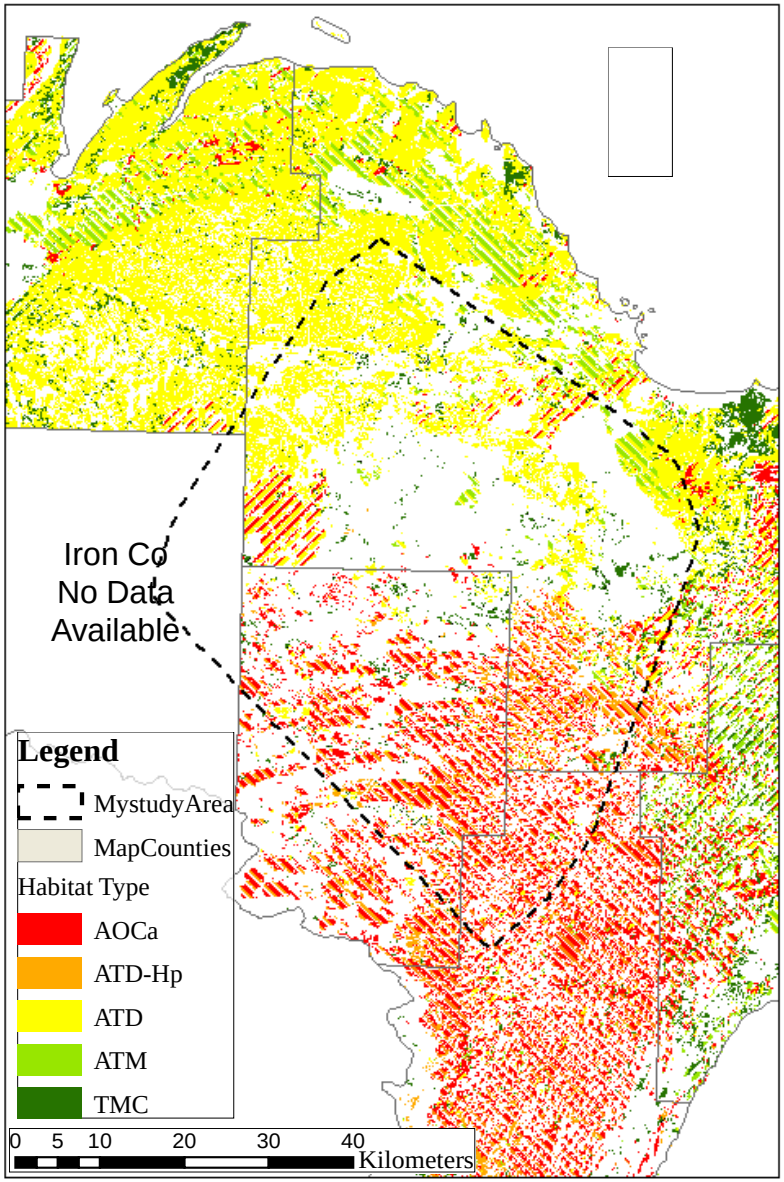
# Many gap- and site-level variables differ between southern and northern regions

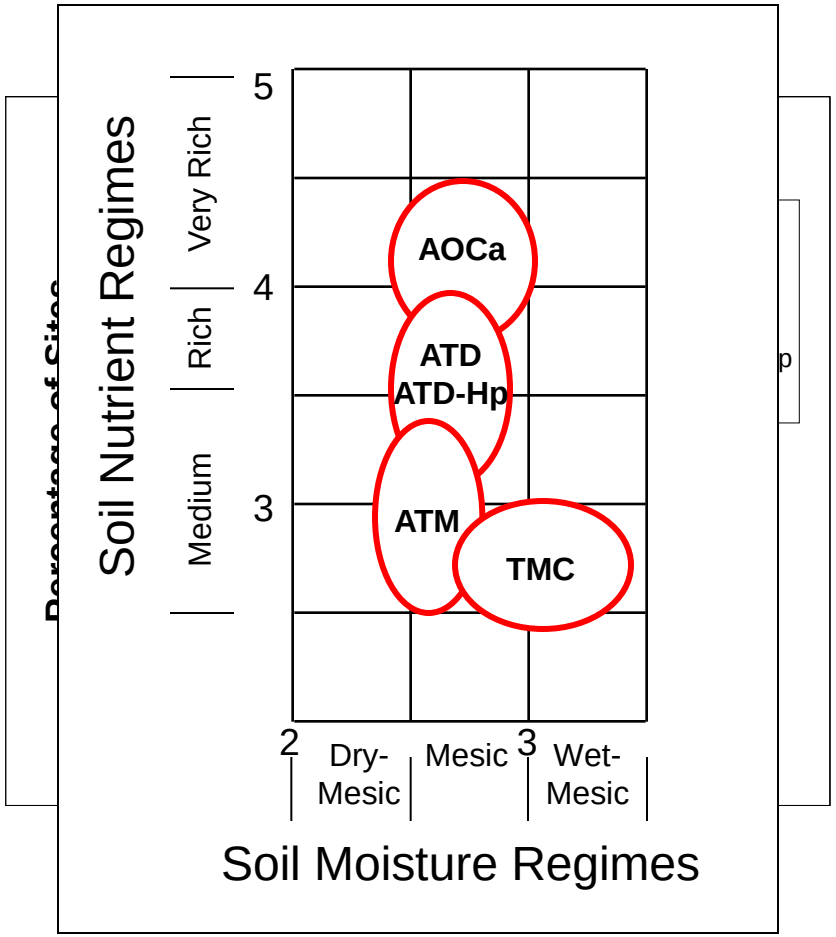



* p<0.05

# Habitat type distribution displays regional variation




Source: MDNR, predicted from NRCS soil survey data

# Discussion and Conclusion

- Results summary
- Caveats
- Management implications

# Hypothesis: A combination of multi-scale factors help explain variation and spatial patterns in northern hardwood regeneration

Yes

**Prediction 1: Gap-level variables affect regeneration**

- Seed source (+)
- Gap size / light availability (+)
- Competing vegetation (-)

Yes

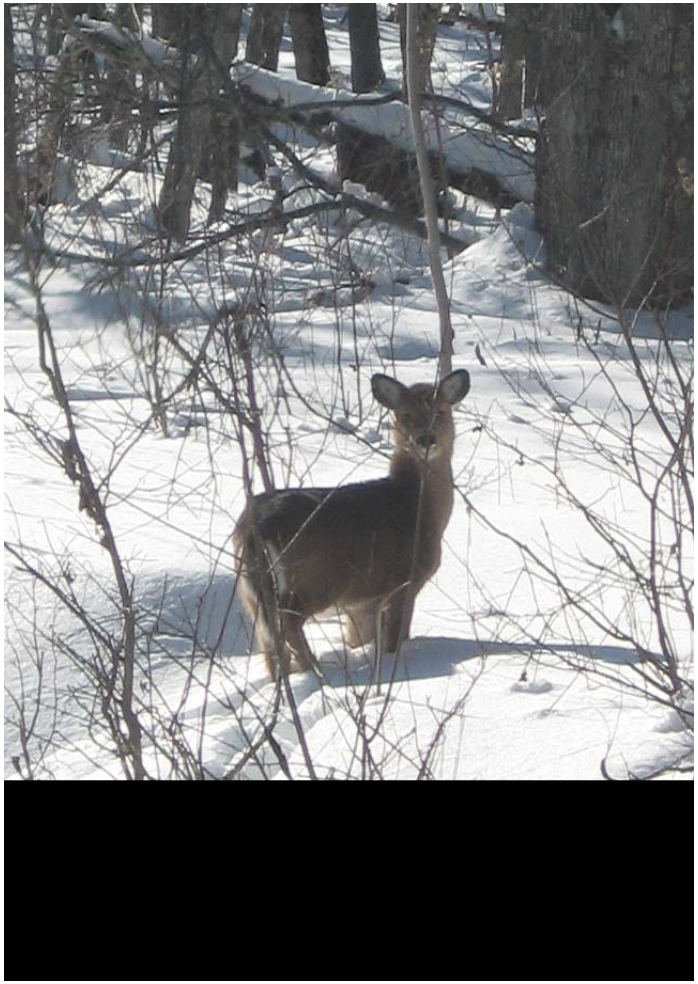
**Prediction 2: Stand-level variables affect regeneration**

- Deer density / browse (-) — Some support
- Habitat type (+) — Important but not in direction expected

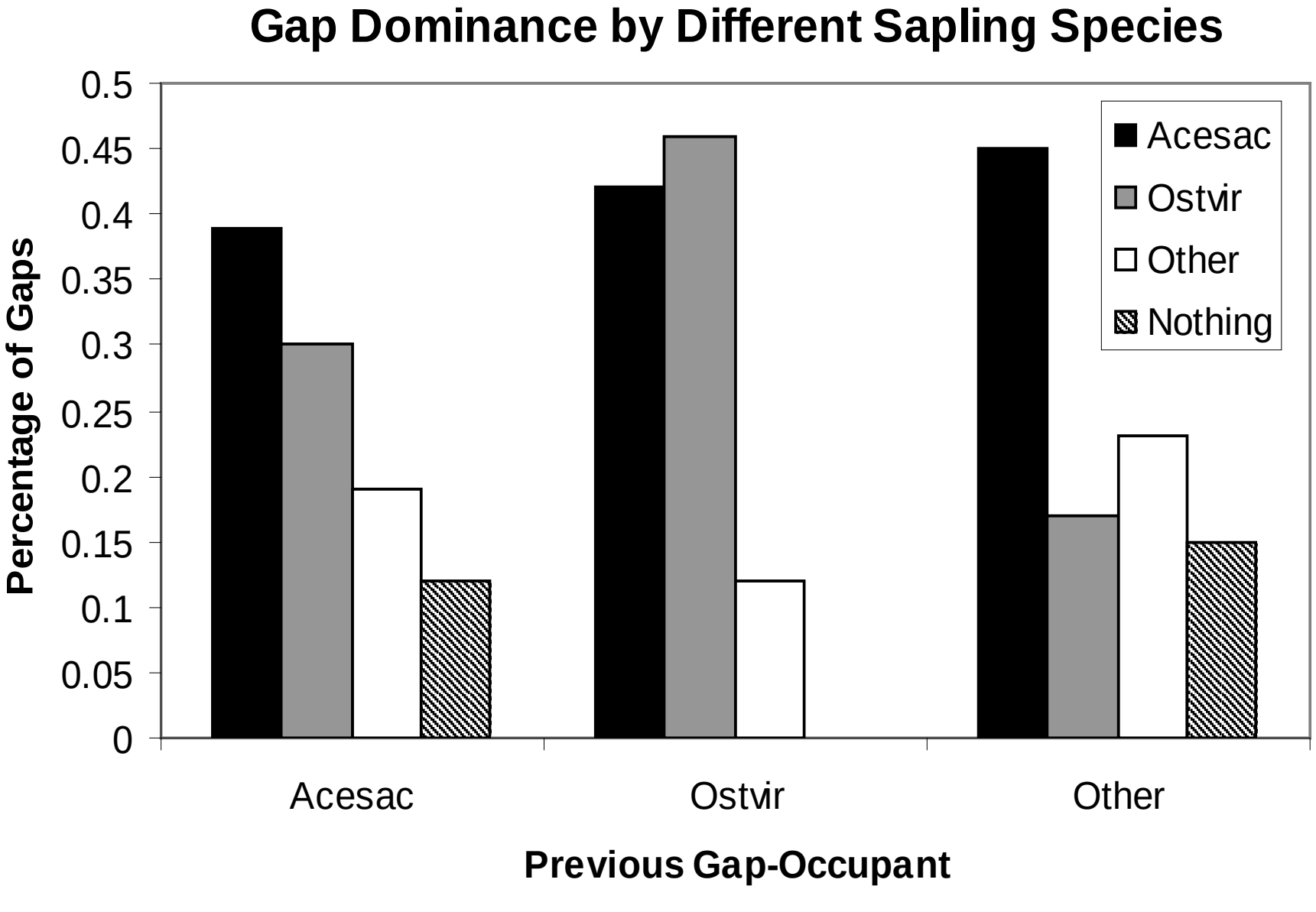
**Prediction 3: Landscape-level variables affect regeneration**

- N-S snow gradient → N-S gradient in deer densities → N-S gradient in sapling densities

Yes but confounded



# Potential for changes in species composition



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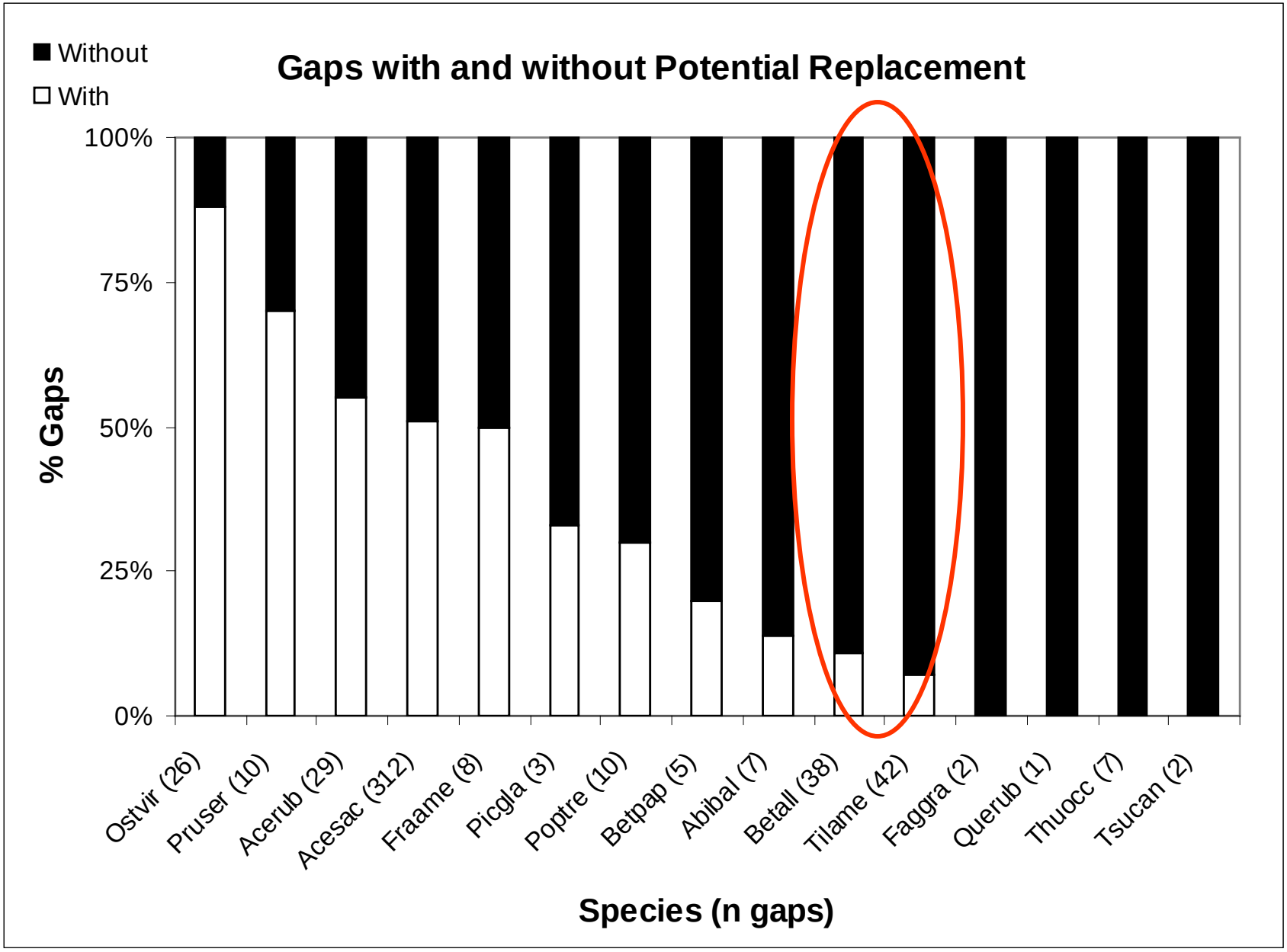


# Management Implications

•"Regeneration of sug[illegible] northern hardwood stands in the Lak[illegible] generally a simple matter" (Tubbs 1968)

FALSE!!!

•Stands with less sugar maple regeneration:

- •More nutrient rich habitat types
- •Southern sites with higher winter deer densities
- •Competition from graminoids and shrubs

•Methods to enhance regeneration:

- •Protect advanced regeneration
- •Increasing seed source and light availability
- •Reduce deer density
- •Herbicide
- •Other harvest techniques (shelterwood)

Q: What is the biggest threat to natural northern hardwood regeneration?

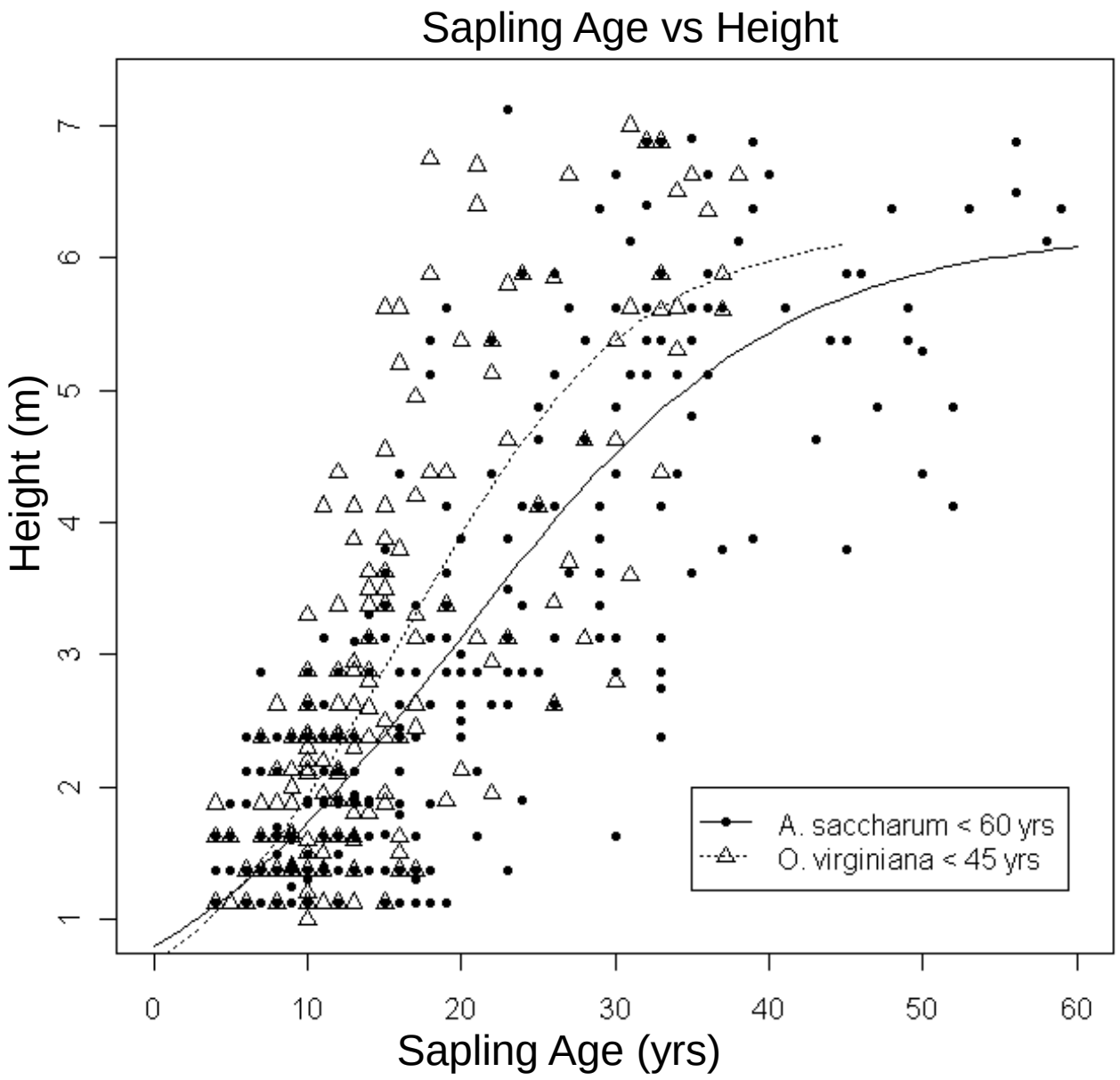
Hint: In this picture

# Thank you! Questions?

And the Answer Is…

# GIANT KILLER FLIES

# Species differences in growth rate



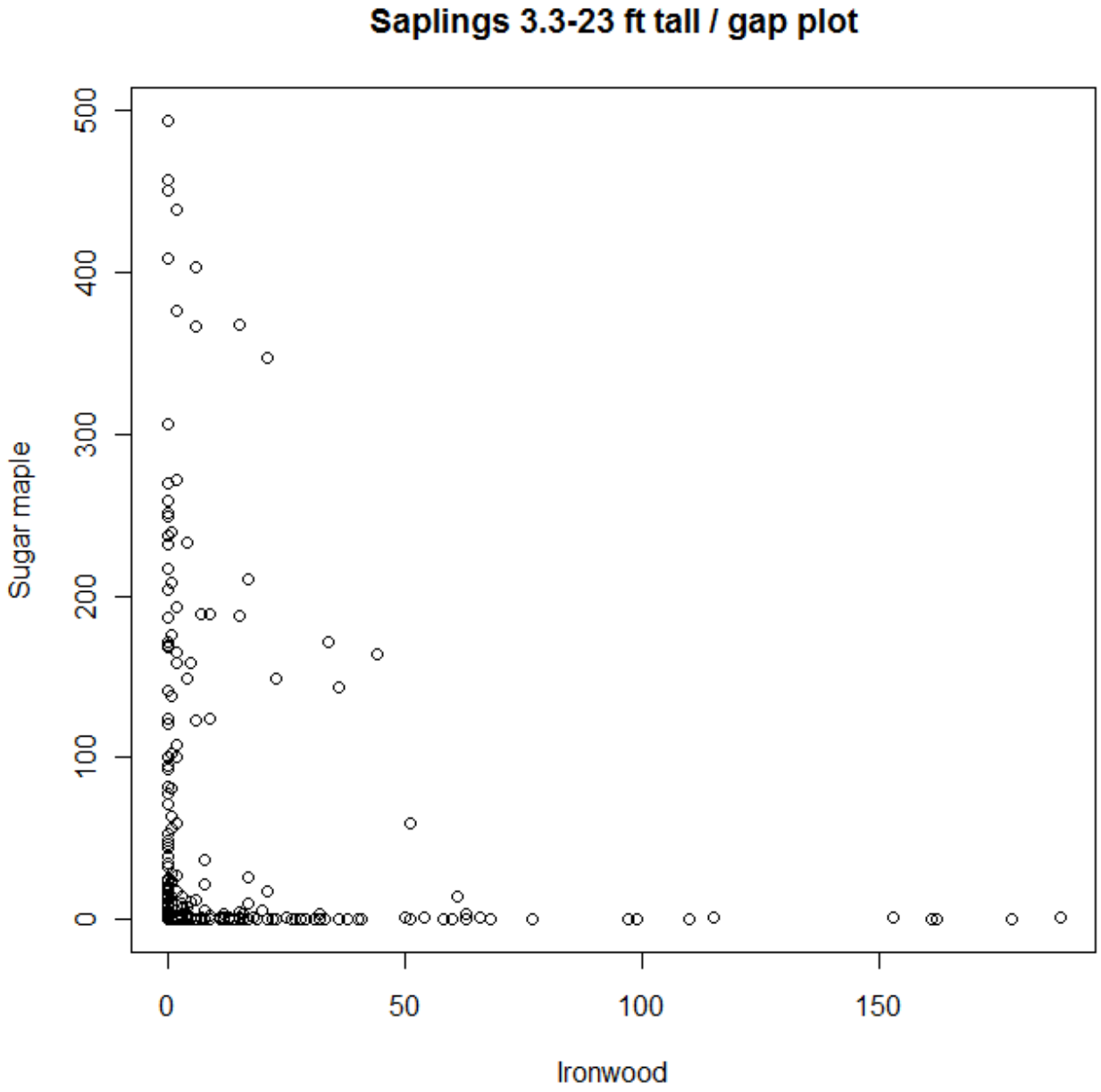

<u>After harvest growth rate affected by:</u>

- Height (+)
- Time since harvest (-)
- Ad regen (-)

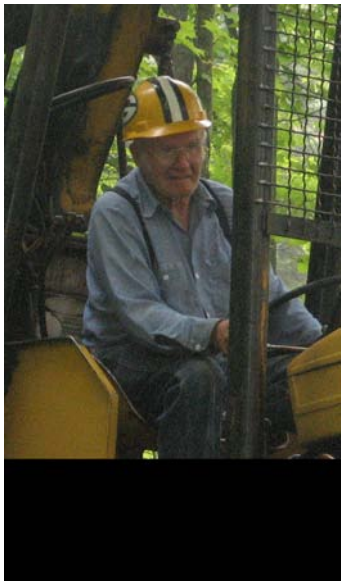
<u>Not affected by:</u>

- Deer density
- Habitat Type
- Canopy openness

# Sugar maple and ironwood trade off dominance



# Acknowledgements




•Charlie Becker with Plum Creek Timber Co., Inc, Greg Lake with American Forest Management, Inc and Jim Ferris with the Michigan Department of Natural Resources for facilitation of field work

•Dr. Mike Walters and Dr. James Millington (MSU) for intellectual support

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•Jim Cousineau for housing and local knowledge

•The National Research Initiative of the USDA Cooperative State Research, Education and Extension Service for financial support

•Family and friends for their encouragement!


# Sugar maple regeneration (3.3-6.6 ft) is affected by both gap- and stand-level variables

| Variable | Mean -> +/-1 Stdev | +/- saplings/plot |
|---|---|---|
| Competing Veg | 42% → 19% | + 0.5 - 1 |
| Canopy Openness | 13% → 20% | + 1 - 2 |
| Time since harvest | 9 yrs → 12 yrs | + 1 - 5 |
| Deer Density | 36 /mi$^2$ → 6 / mi$^2$ | |
| TMC | | |
| ATM | | |
| ATD | | |
| ATD-Hp | | |

Estimated at AOCa stand