Sugar Maple Regeneration and Decline

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Tara Bal

Research Assistant Professor
Master of Forestry Program Coordinator
tlbal@mtu.edu
SFRES
Michigan Technological University

Michigan Tech
Michigan Technological University
School of Forest Resources and Environmental Science

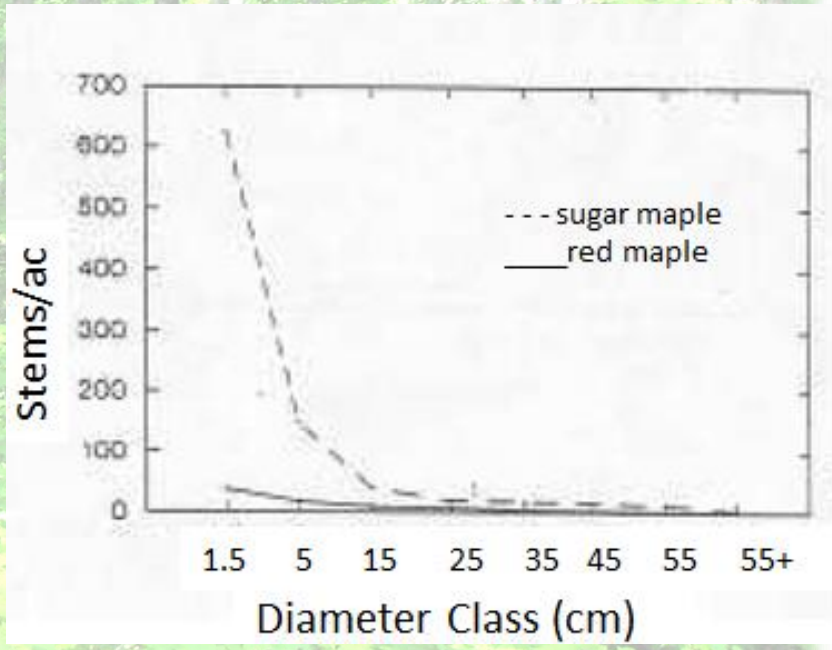
Outline

Sugar Maple Regeneration and Decline

- Background
  - Regen Ecology
  - Known Factors for Failure
- Sugar Maple Health Monitoring in MI, WI, MN
  - Dieback/Decline
  - Regeneration Correlates
- Interaction of Factors
- Management Strategies

Regen Ecology

- Classic shade tolerant
- Large #'s seeds every 2-3 years
- # of seeds correlated with size/density, not age
- Common, 50% seedling mortality 1 year
  - 85% after 5 yrs only 2 leaves (Gardescu, 2003)
- Can survive >30 yrs at <1m height
- Common, 150,000/acre seedlings



Demographic curves, Dukes Research Forest, Marquette, MI (Kerry Woods). In Jenkins et al., 1997

Sugar Maple Regen Failure

Recruitment failures (no saplings in understory)

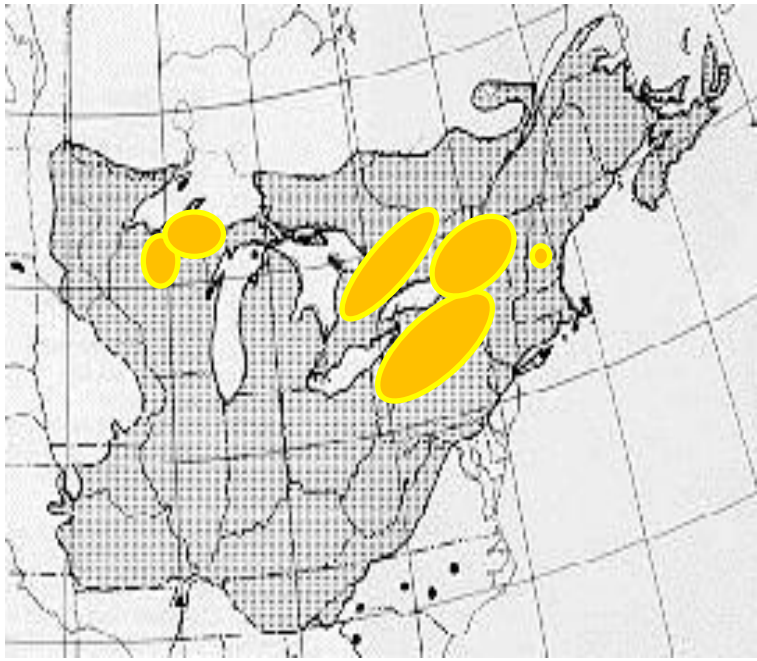
Regeneration failures (Seedlings either do not emerge or exhibit excessive, early mortality)

- Previously reported on private/public lands, even old-growth forests
- Reports of sugar maple regen failure relatively recent unless associated with deer…

Sugar Maple Regeneration Failure

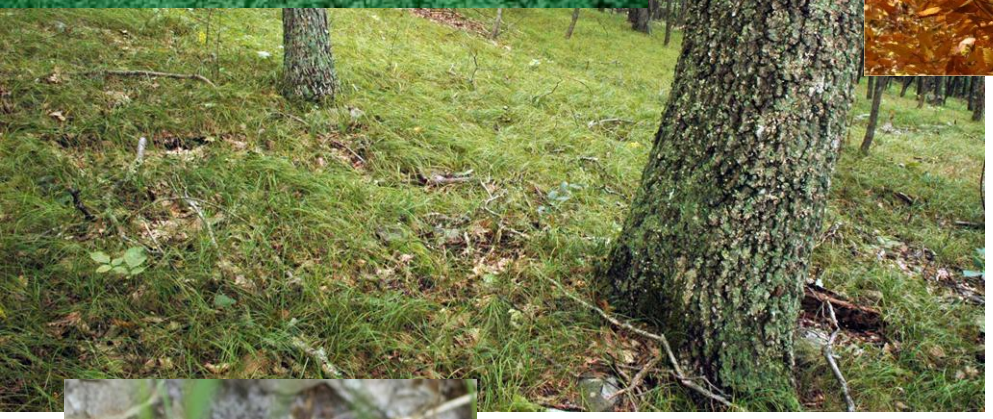
Where has this been studied? (examples)

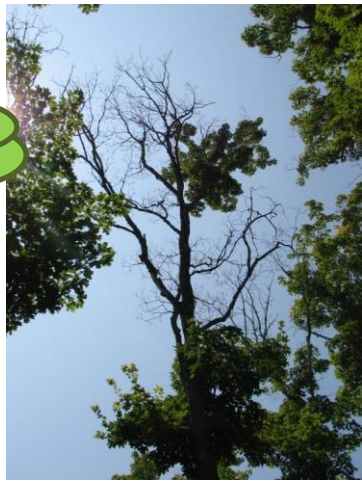
- **RESEF network, Quebec, Canada**
  - Duchesne et al, 2005
- **Adirondacks, NY**
  - Gardescu 2003, Jenkins 1999
- **Hubbard Brook Exp. Forest, NH**
  - Juice et al., 2006
- **Alleghany National Forest, PA**
  - McWilliams et al, 1996
- **Chequamegon-Nicolet NF, WI**
  - Powers,Nagel 2009
- **Upper Peninsula, MI**
  - Matonis et al, 2011, Donovan 2005



- TAKE AWAY: May be northern hardwoods but *many different* conditions, abiotic and biotic

Factors Associated with Maple Regeneration Failures





Sugar Maple Dieback Monitoring 2009-2012

Crown & Bole Biometrics

Growth and Climate

Forest Floor Condition

Sapstreak Investigation

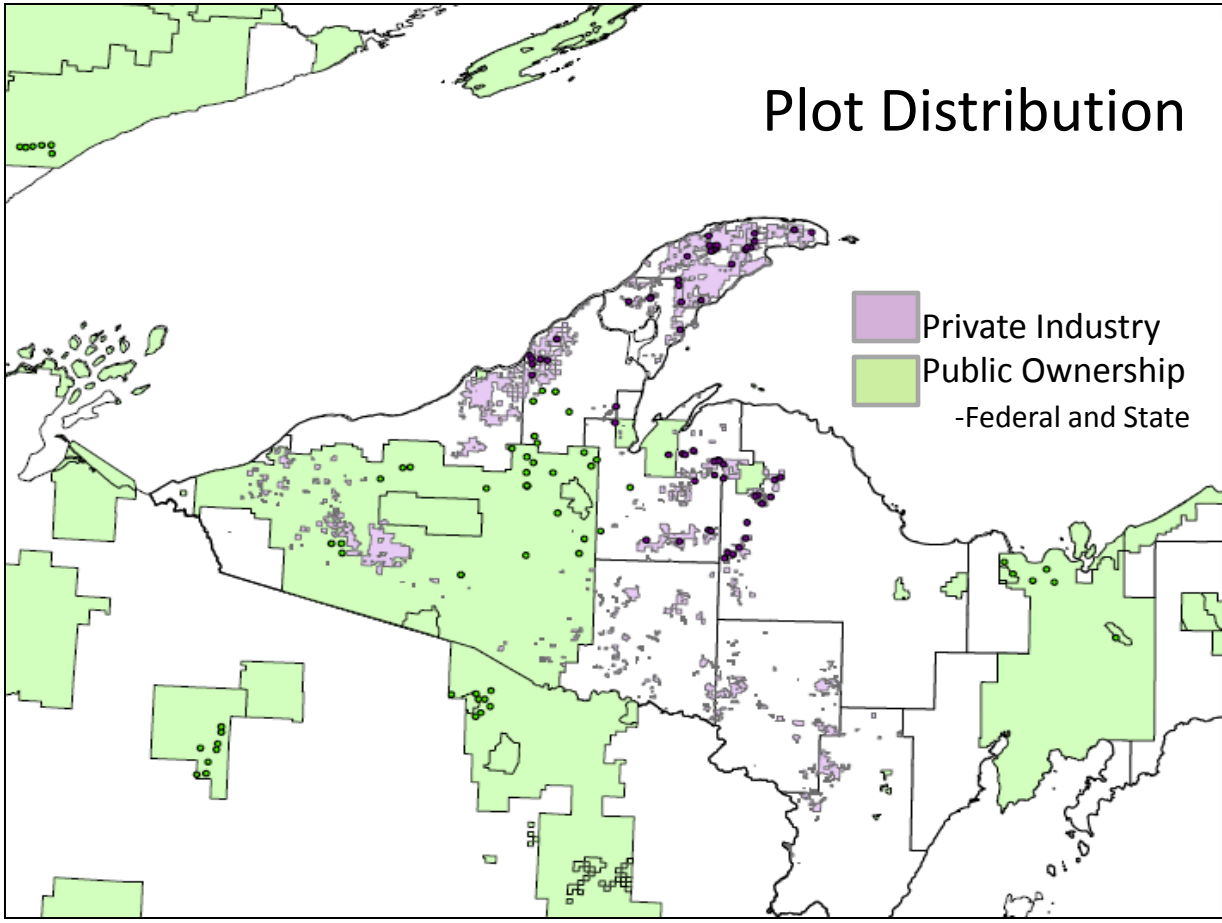
Soil Nutrients

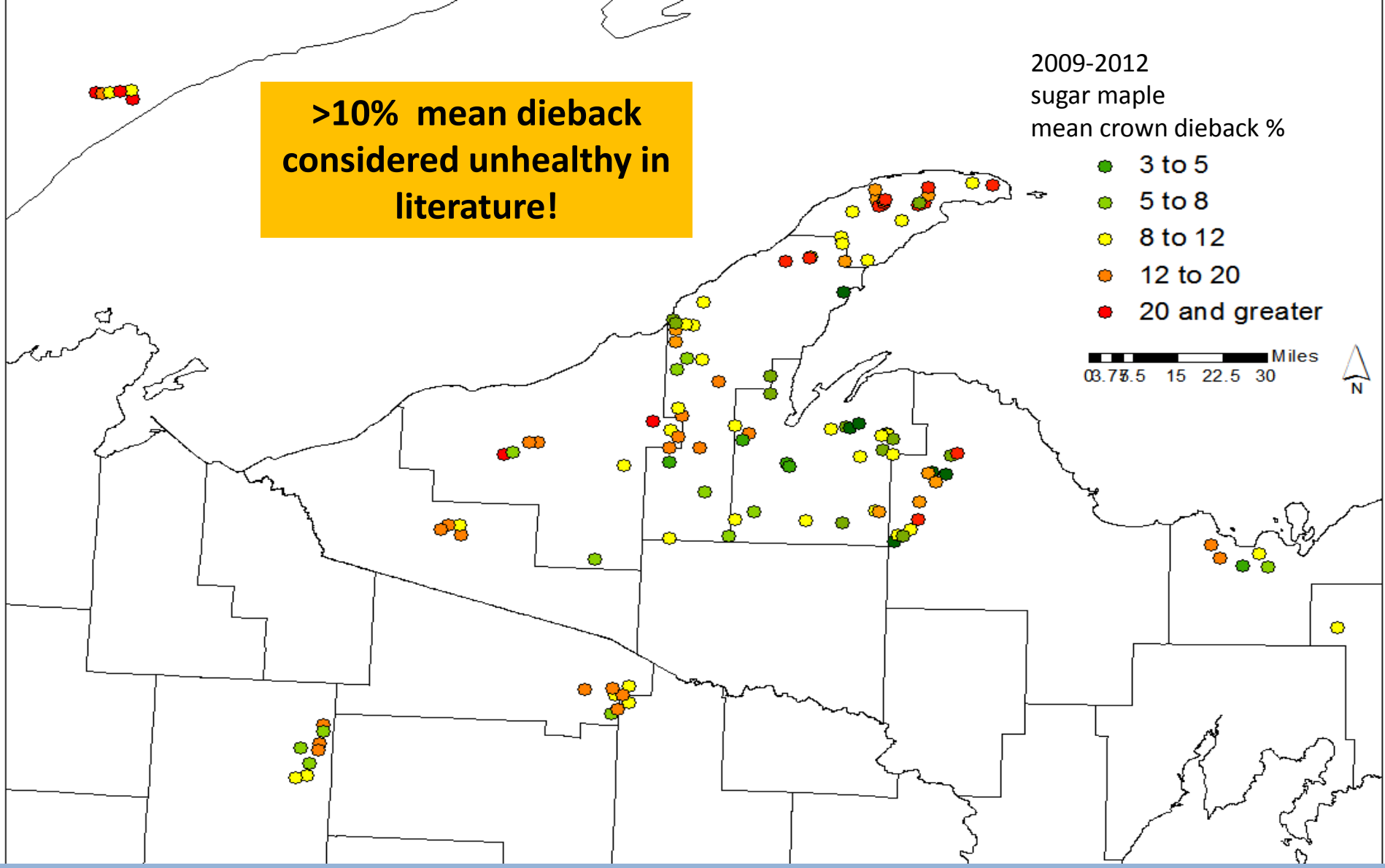
Foliage Nutrients

Regeneration Counts

Herbaceous Comp.

Ownership, Management





Harvested trees no longer included in averages.

Trees 100% dead in plot establishment year were not included in the plot average dieback .

Subsequent natural mortality was included in the plot average to capture dying trees.

Sugar Maple Dieback Monitoring

mean crown dieback (2009-2012)

Modeled plot and edaphic variables(n=65):

Significant Variables	p value	Trend direction
Forest floor rating (worms)	0.009	+
Soil Carbon	<0.001	+
Soil Manganese	<0.001	-
Herbaceous Cover	<0.001	-

Sugar Maple Dieback Monitoring

Mean SM regeneration counts (2009-2012)

Modeled plot level variables (n=25):

Significant Variables	p value	Trend Direction
Herbaceous Diversity	0.008	-
Mean SM DBH	<0.001	+

Sugar Maple Dieback Monitoring

Mean SM regeneration counts (2009-2012)

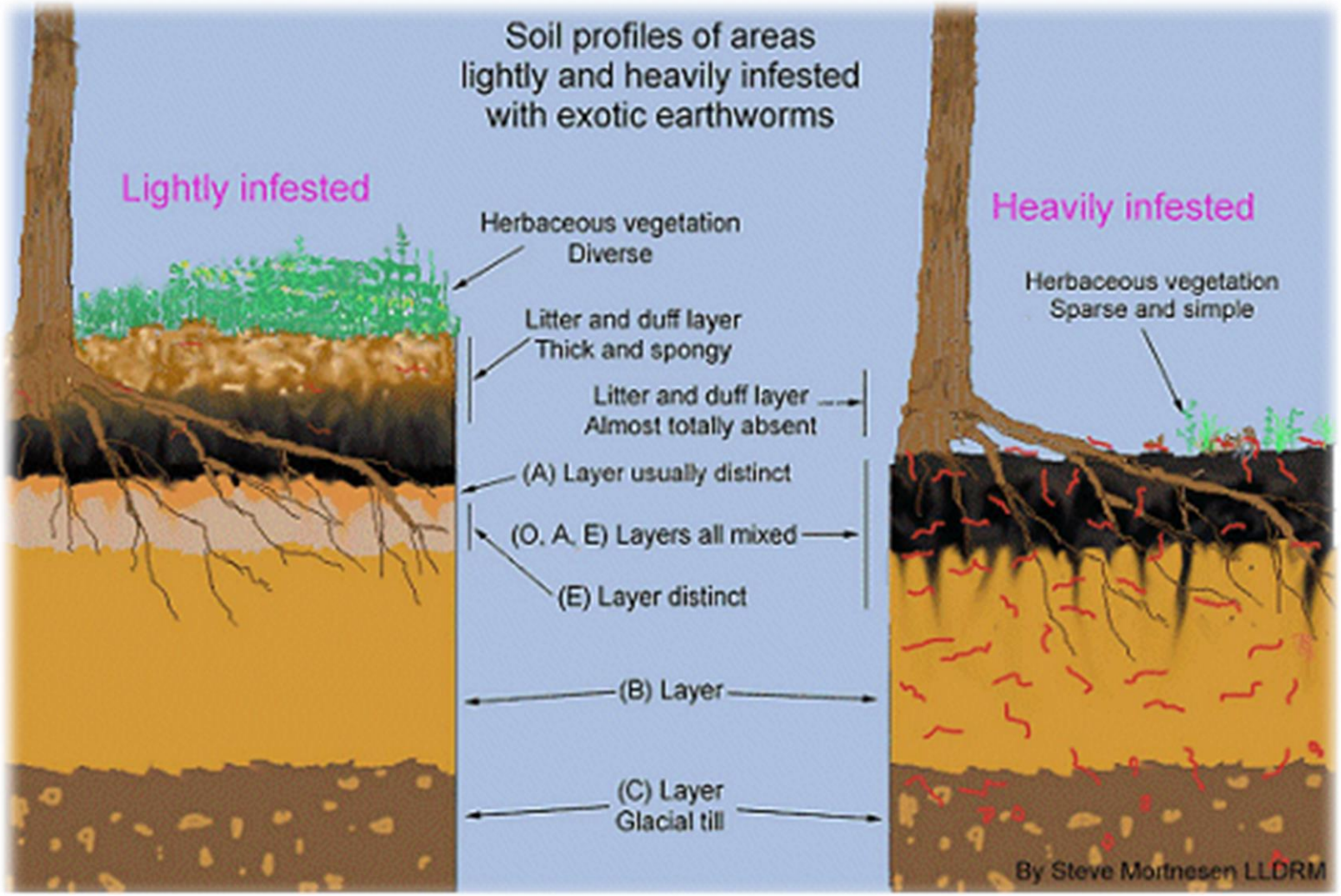
Modeled plot and edaphic variables (n=65):

Significant Variables	p value	Trend Direction
Mean SM Tree Height	<0.001	+
Seedling Mortality Rating (soil survey)	0.001	+
Soil Calcium	0.002	+
Soil Potassium	0.004	-
Soil Calcium/Aluminum ratio	0.039	-

*No significant beech component in these plots.

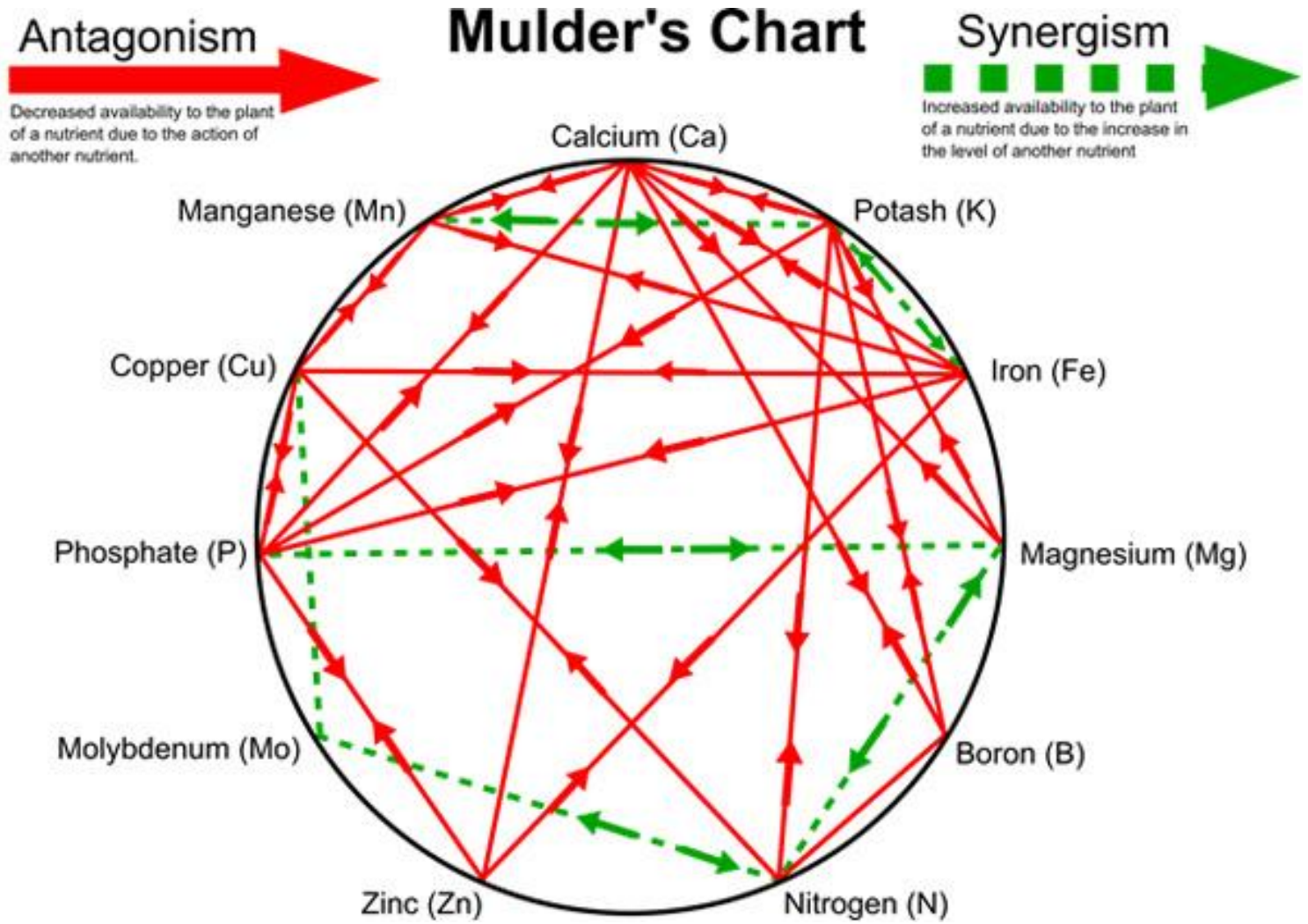
**Did not include deer density.

What do earthworms do?



http://www.nrri.umn.edu/worms/forest/soil_layers.html

What about soil nutrients?



http://nutriag.com/article/mulderschart

Different Combinations of Interactions

- Intensive forest management and high deer density alters tree species density and diversity
- Deer presence may facilitate higher earthworm populations
- Earthworms facilitate sedge mats, invasive plants, expose soil, disturb moisture, temperature, nutrient regimes
- Disturbed nutrients, earthworms, impact seedling mycorrhizae
- Poor soil fertility itself predisposing trees to additional stress

Key: different combinations of factors across different scales are impacting regeneration

Management Strategies

- Site Selection becomes critical
  - *Does it need to convert?*
- Long term single tree selection
  - Dependable
  - Alters species diversity, Sugar maple dominance increasing over time, but if regeneration is failing?
  - *Change to even-aged?*
- Canopy gaps, strip clearcuts, shelterwoods?
  - Quickly releases cohorts into sapling size classes
  - Sugar maple is not always tolerant of these, maybe better for other underrepresented species, alters microenvironment…i.e. what is the optimum gap size?
  - *Allow canopy to close to reduce invasive plants before continuing uneven aged? Could promote other species?*

Management Strategies

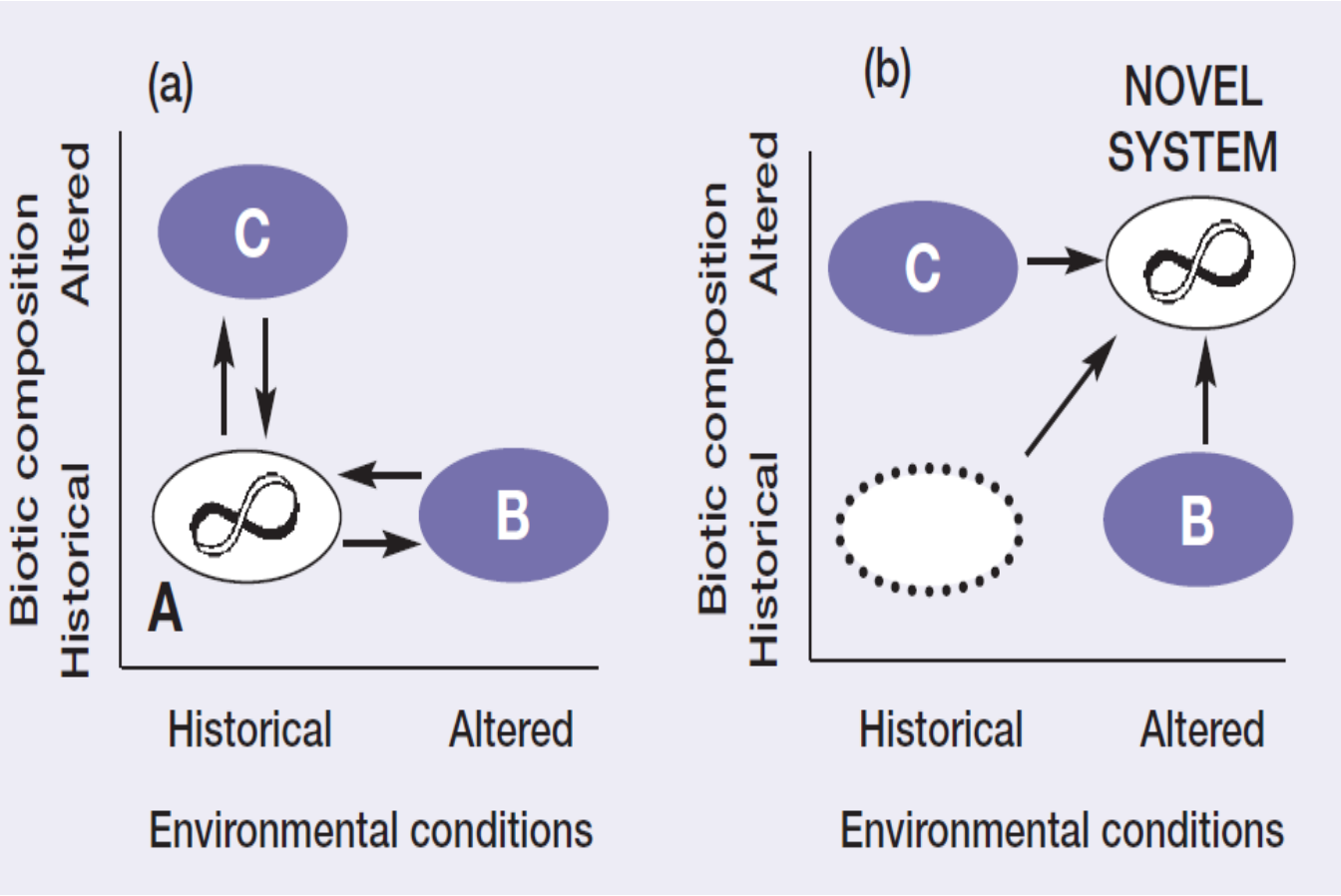
- Scarification, Herbicides
  - Typically reduces invasives and tree regeneration
  - *May be necessary with any invasive plant species*

- Fertilization, reversing soil acidification, liming
  - Issues doing this over large scale
    - $, timing, method, nutrient interactions, declining legacy effects…
  - Likely practical only in small areas
  - *Fertilize sugarbushs?*

- Earthworm BMPs
  - *Powerwash equipment, use local road grading material*

Bottom Line: Options available to attempt resolving issues but uncertainty exists

Traditional vs Novel Systems



Seastedt, Hobbs, Suding (2008) **Management of novel ecosystems: are novel approaches required?** ***Front Ecol Environment*** **6(10): 547–553**

Management Strategies

- Think creatively outside the box
- Continue monitoring long-term silviculture experiments
  - Need new harvesting and growth trials in the face of climate change, invasive species, deer browse, earthworms, changing conditions
  - Examine factors concurrently!!

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Selected References (or tlbal@mtu.edu)

Bal, T.L. 2013. Evaluation of sugar maple dieback in the upper great lakes region and development of a forest health youth education program. PhD Dissertation. Michigan Technological University. 176 pgs.

Bal, T.L., Storer, A.J, Jurgensen, MF, Doskey , P, and Amacher, M. 2014 Differing nutrient stresses predispose and contribute to sugar maple dieback across its northern range: a review. Forestry (submitted March 2014).

Cleavitt, N.L. et al., 2011. Regeneration ecology of sugar maple (*Acer sacharrum*): seedling survival in relation to nutrition, site factors, and damage by insects and pathogens. Can. J. For. Res. 41: 235-244.

Côté, B. and Ouimet, R. 2003. Decline of the maple-dominated forest in southern Quebec: impact of natural stresses and forest management. Environ. Rev. 4: 133-148.

Donovan, 2005. Chronic regeneration failure in northern hardwood stands: a liability to certified forest landowners. Michigansaf.org/Tours/05Deer/08-DonovanSlides.pdf

Duchesne, L. et al., 2005. Changes in structure and composition of maple-beech stands following sugar maple decline in Quebec, Canada. Forest Ecology and Management 208: 223-236.

Gardescu, S. 2003. Herbivory, disease, and mortality of sugar maple seedlings. Northeastern Naturalist 10: 253-268.

Garrett, P.W. and Graber, R.E. 1995. Sugar maple seed production in northern New Hampshire. Res. Pap. NE-697. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 6p.

Hane, E.N. 2003. Indirect effects of beech bark disease on sugar maple seedling survival. Can. J. For. Res. 33: 807-813.

Jenkins, J.C., 1997. Hardwood regeneration failure in the Adirondacks: preliminary studies on incidence and severity. WCS Working Paper No. 9 (70 pgs).

Juice, SM and Fahey, TJ, etal, 2006. Response of sugar maple to calcium addition to northern hardwood forest. Ecology 87: 1267-1280.

Kern, CC, S'Amato, AW., Strong, TF, 2013. Diversifying the composition and structure of managed, late-successional forests with harvest gaps: what is optimal gap size? For. Ecol and Manage. 304: 110-120.

Marks P.L. and Gardescu, Sana, 1998. A case study of sugar maple (Acer saccharum) as a forest seedlings bank species. J of Torrey Botanical Soc. 125: 287-296.

Matonis, M.S. et al., 2011. Gap-, stand-, and landscape-scale factors contribute to poor sugar maple regeneration after timber harvest. Forest Ecology and Management (in press).

McWilliams, W.H. et al., 1996. Characteristics of declining forest stands on the Alleghany National Forest. USDA Forest Service, Northeastern Forest Exp. Station. Research Note NE-360.

Powers, M.D. and Nagel, L.M. 2009. Pennsylvania sedge cover, forest management and deer density influence tree regeneration dynamics in a northern hardwood forest. Forestry 82: 241-254.

Forest Floor Condition, Earthworm Impact Rating Scale (Lilleskov, USFS)

Rating	Description of class characteristics
1	No forest floor. Previous year's litter over mineral soil. Worm sign abundant.
2	No humus, large old leaves under litter. Worm sign present or absent. Roots absent.
3	No humus. Small leaf fragments, larger old leaves present. Sparse roots. Some worm sign , but rare large casting piles.
4	Humus patchy, may be mixed in soil. Some roots, but not thick. Small worms may be found in the forest floor, but no large castings or middens.
5	Humus fully intact. Roots present in humus and leaf fragments. Forest floor coherent when picked up with intact recognizable layers. No worms or worm sign present.

Example: KBIC genetic diversity trials

- 230acres, Baraga County, MI
- Partners: U.S. Forest Service, Michigan Tech, State Nurseries
- Expected outcomes include:
  - Establish sugar maple seedlings from various plant hardiness zones in the Upper Peninsula of Michigan.
  - Determine if variants are capable of competing with local sugar maple.
  - Determine if variants can outperform local sugar maple on a warmer and drier site.
  - Enhance genetic diversity of the local sugar maple population.

http://forestadaptation.org/KBIC_demo