

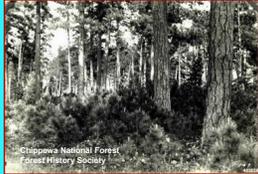
### Fire and Great Lakes Red Pine Woodlands: Busting Myths and Advancing Management

**-Context: Red Pine Ecosystems** ★

**-What do we know now that we did not know before?...including role of fire**

**-Advancing our silviculture to reflect this understanding**

*Generalizable to other fire-dependent woodland ecosystems*



Chippewa National Forest  
Forest History Society

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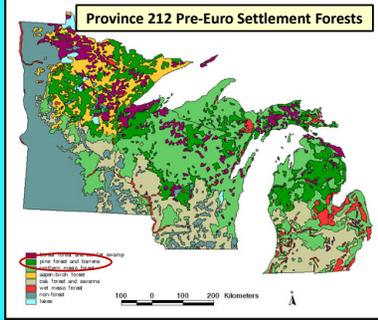




1

### Context    Laurentian-Acadian Northern Pine-(Oak) Woodlands

#### Province 212 Pre-Euro Settlement Forests



1.4 million ha pine



Greg Corace

2

### Context

**Red Pine (mixed-pine) Forests in the Lake States Now**

- Reduced in area: from 1.4 million ha to ~250,000 ha
- Overly red pine dominated; high stocking
- Fire excluded, often
- Dense woody shrubs (hazel)
- Plantations (76% in MN,MI,WI)
- High economic value
- Timber-focused silviculture

Year	Activity
0	Clearcut harvest
1	Site preparation
2	Plant in spring
2-4	Browsing control
4-5	Competition control
30	First thinning
45	Potential second thinning
60	Potential third thinning
50-90	Final harvest



~300,000-450,000 cords harvested annually  
-Sawtimber, utility poles, cabin logs

**Past belief: this somehow emulated natural dynamics...?**





3

### What do we know now that we did not know (or appreciate) 30 years-ago?

**Red pine occurs in some abundance in many *different* Native Plant Communities/Habitat Types/Ecosystems**

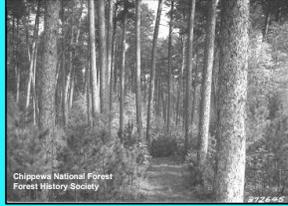
**MN Native Plant Communities (with abundant red pine):**

- Northern Dry-Mesic Mixed Woodland (FDn33a)
- Northern Dry-Sand Pine Woodland (FDn12b)
- Northern Dry-Bedrock Pine (Oak) Woodland (FDn22b,d)
- Northern Poor Dry-Mesic Mixed Woodland (FDn32a,b)
- Northern Mesic Mixed Forest (FDn43a)
- Central Dry-Mesic Pine-Hardwood Forest (FDc34a)

**Similar ecosystems occur in WI and MI**



Shawn Fraver



Chippewa National Forest  
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**Myth Busted: red pine ecosystems are all the same**

**Diversity of Ecosystems= Diversity of Management Approaches ...or at least it should...but does it?**

4

**We know a lot more about disturbance regimes-fire**

Heinselman (1996): return interval (yrs)  
 -Crown fire: 150-250 (stand replacing)  
 -Surface fire: 5-50

**Myth Busted: stand-replacing fire defined the disturbance regime**

**Northern Dry-Mesic Mixed Woodland (FDn33a)**  
 -Infrequent catastrophic fire rotation of 220 years  
 -Frequent, low-intensity surface fires, w/ rotation of 75 yrs

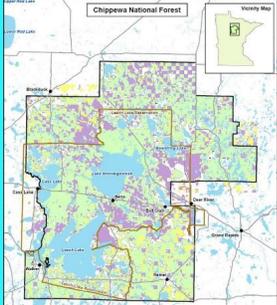
**Mixed-severity fire regimes, including less-than-stand-replacing fire....**  
 (Bergman 1924, Shirely 1932, Eyre and Zehngraff 1948)

**Landscape**  
 Fire intervals: 1-40 yrs  
 Mean fire interval: 6.6 yrs  
 Range reflects variation in Indigenous use spatially and temporally

Stambaugh et al. 2021. Forest Ecology and Management

**Similar estimates in WI and MI**

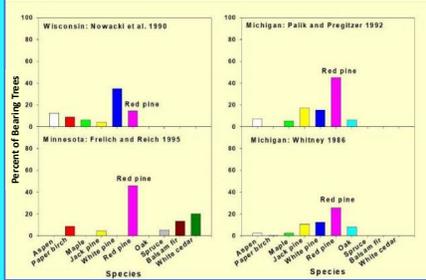
Recent quantitative estimates: Leech Lake Band of Ojibwe Homeland-Chippewa NF




Jack McGowan-Stinski

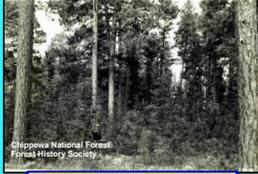
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**We know that red pine forests were mixed-species ecosystems**



Wisconsin: Nowacki et al. 1990  
 Michigan: Pakk and Pragtizer 1992  
 Minnesota: Frelich and Reich 1995  
 Michigan: Whitney 1986

**FDn33a: red pine, eastern white pine, jack pine, trembling aspen, paper birch, balsam fir, red maple, big-tooth aspen, black spruce, northern red oak, white spruce**



Chippewa National Forest Forest History Society

**All three native pines are in this photo**

**Myth Busted: Red pine forests were mostly red pine**

6

**We know that red pine ecosystems were often woodlands with a variably open canopy:**

**Why?: Mixed-severity fire regimes, including less-than-stand-replacing fire**

**Also Mixed-agent: Armillaria, wind**

**MN Native Plant Communities (with red pine):**  
 Northern Dry-Mesic Mixed Woodland (FDn33a) 50-75%  
 Northern Dry-Sand Pine Woodland (FDn12b) 50-75%  
 Northern Dry-Bedrock Pine (Oak) Woodland (FDn22b,d) 25-50%  
 Northern Poor Dry-Mesic Mixed Woodland (FDn32a,b) 25-100%  
 Northern Mesic Mixed Forest (FDn43a)  
 Central Dry-Mesic Pine-Hardwood Forest (FDc34a) 50-100%

**Myth Busted: closed canopy, high density forests**



Greg Corace



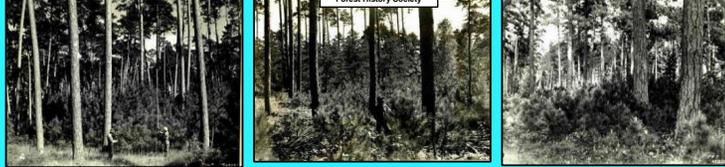
Seney NWR

7

**We know that red pine ecosystems had complex age structures:**

**Overstory present during regeneration events**

**Evidence for structurally complex stands**  
 (Bergman 1924, Shirely 1932, Eyre and Zehngraff 1948)



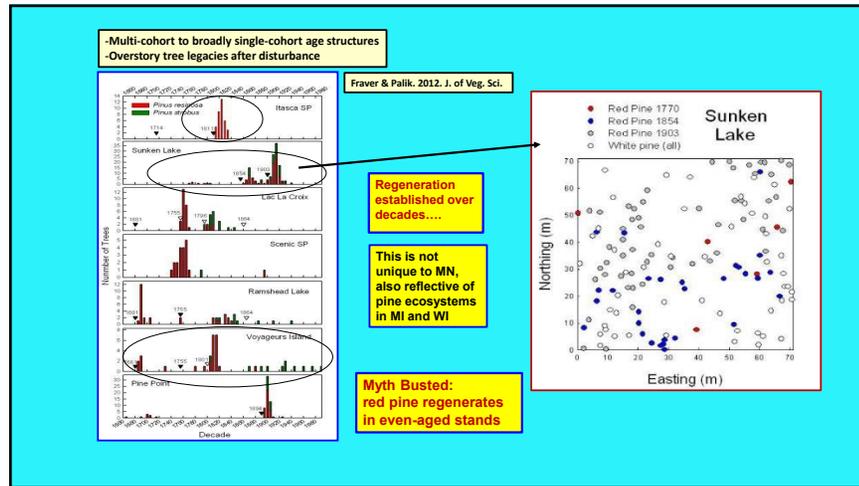
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**"Nature's own group selection: red pine reproduction was generally shaded out within a few years except in openings caused by tree mortality."**

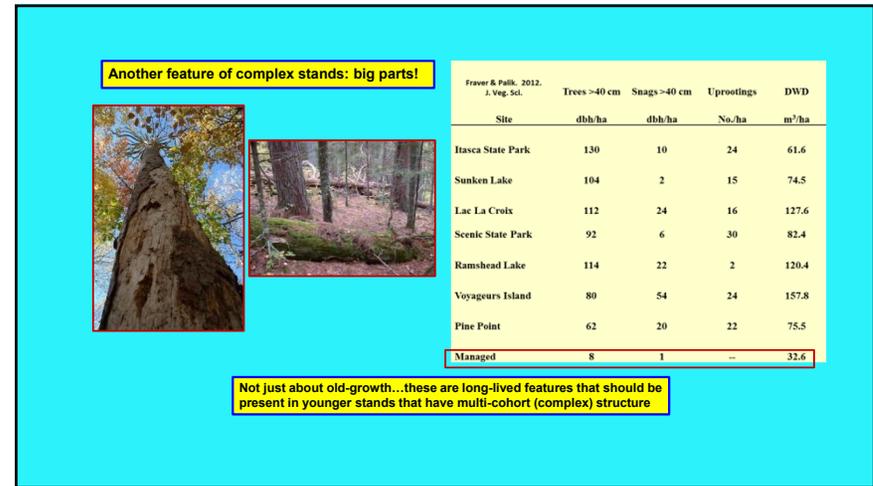
**"After patchy disturbance in red pine stand (140 years old), red pine reproduction established in groups."**

**"Large old pines and red pine cohort regeneration, Pike Bay, Chippewa National Forest."**

8



9



10

**To summarize natural fire regime and resultant structure:**

- Mixed-severity (including less than stand-replacing) fire regime
- Openings from other disturbance agents
- Complex and variable age structures
- Mixed-species
- Woodlands with variable canopy cover

**Management rarely emulates this.....**

**-Even aged stands**

- Spatially homogeneous in structure & composition
- High stocking (favoring the A-line)
- Generally shorter rotations: 60-120 years
- Strongly red pine dominated
- Can have dense shrub layer
- Even-age regeneration systems

**But, you think, timber stands are younger stands...of course they display SSS?**

**Red Pine Managed for Timber (SSS):**

- Structurally simple
- Spatially simple (homogeneous)
- Species simple (tree species poor)

**Especially plantations, but not exclusively**

11

**Yes but...They are too simple!**

- pine ecosystems have more complexity/diversity at all developmental stages
- management truncates development, so little structure is carried into new stand

**Naturally, young stands (cohorts) might develop in a context like this:**

**How to reduce SSS in all stages?**  
**Natural development model for silviculture**

12

**Red Pine Natural Development Model** **Mixed-Severity Archetype** Palik et al. 2020. Waveland Press.

Stage or Event	Attribute	Cause or Consequence
Disturbance and Legacy Creation	Spatially heterogeneous live and dead tree legacies	Results from near stand replacing to patchy fire
Preforest Stage (1-60 yrs)	Extended and important or locally absent, lasting from < 1 to several decades	Herb and shrub dominated; or prolific hardwood sprouting may bypass PFS; <b>surface fire?</b>
Young Forest Stage (40-70 yrs)	40-70 years for new cohort red pine that may establish with intolerant species	Red pine densities low initially, increasing over time in mixture with other species; <b>surface fires</b> in later development
Mature Forest Stage (70-150 yrs)	Red pine dominated, other species present; small-scale disturbance increases heterogeneity and dead/decadent trees	<b>Surface fires</b> limit recruitment of sensitive species except in fire-skips; new pine establishment in openings
Old Forest Stage (+150 yrs)	Red pine dominated, with eastern white pine; heterogeneous canopy; broadly even-aged to several cohorts	Long-lived pines accumulate complex structure; <b>patchy surface and crown fires</b> , wind, root-rot gaps, create heterogeneity

13

**Preforest:** herbs and shrubs dominate unless...

**Young stage:** pines establish slowly, lower stocking generally

**Mature stage:** patch mortality from fire etc.

**Old stage:** multi-cohort, large structures

**Advancing our silviculture to reflect this understanding**

14

**Ecological Silvicultural System: Great Lakes Mixed-Pine Ecosystem (Mixed-severity Archetype)** Palik & D'Amato. 2023. Wiley Press. Palik & D'Amato. 2019. Ecosystem Processes

Developmental Stage/Event	Duration (yrs)	Example Activities
Disturbance and Legacy Creation	0	Variable retention harvest; deadwood creation
Preforest	1 to 5+ (20+)	Site preparation; competition control; regeneration
Young Forest (early)	5 to 30	Regeneration; browse control; release
Young Forest (later)	30 to 70	Variable density thinning (VDT)
Mature Forest	70 to 150	VDT; regeneration in VDT gaps; deadwood creation; competition control
Old Forest	+150	Variable retention harvest
		Decadence/deadwood creation; VDT; regeneration in openings; competition control; VRH?

15

**Variable retention harvesting (VRH)...to emulate natural disturbance and structural outcomes**

For pine, VRH can be variable in practice: dispersed to aggregate

-Some overstory present after harvesting...like natural disturbance  
-These are actual examples of implementation

16

Developmental Stage/Event	Duration (yrs)	Example Activities
Disturbance and Legacy Creation	0	Variable retention harvest; deadwood creation
Preforest	1 to 5+ (20+)	Site preparation; competition control; <b>Rx fire</b> ; regeneration
Young Forest (early)	5 to 30	Regeneration; browse control; release
Young Forest (later)	30 to 70	Variable density thinning (VDT); <b>Rx fire</b>
Mature Forest	70 to 150	VDT; regeneration in VDT gaps; deadwood creation; competition control- <b>Rx fire</b>
Old Forest	+150	Decadence/deadwood creation; VDT; regeneration in openings; competition control- <b>Rx fire</b> ; VRH?





**Treatments:**  
-Site preparation; **Rx fire**  
-Regeneration

**Rx Fire after harvest**  
-create seedbeds  
-reduce competition  
-encourage **preforest** condition

17

Developmental Stage/Event	Duration (yrs)	Example Activities
Disturbance and Legacy Creation	0	Variable retention harvest; deadwood creation
Preforest	1 to 5+ (20+)	Site preparation; competition control; <b>Rx fire</b> ; regeneration
Young Forest (early)	5 to 30	Regeneration; browse control; release
Young Forest (later)	30 to 70	Variable density thinning (VDT); <b>crop tree</b> release; <b>Rx fire</b>
Mature Forest	70 to 150	VDT; regeneration in VDT gaps; deadwood creation; competition control- <b>Rx fire</b>
Old Forest	+150	Decadence/deadwood creation; VDT; regeneration in openings; competition control- <b>Rx fire</b> ; VRH?



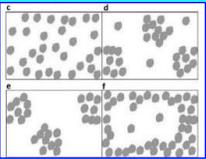

**Goals:**  
-Direct development in younger stands to create complexity, heterogeneity, and diversity...*Reduce SSS!*

**Treatments:**  
-Variable density thinning  
-Enrichment regeneration  
-Rx fire in later stage

18

Developmental Stage/Event	Duration (yrs)	Example Activities
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Preforest	1 to 5+ (20+)	Site preparation; competition control; <b>Rx fire</b> ; regeneration
Young Forest (early)	5 to 30	Regeneration; browse control; release
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**Variable Retention Harvest**

19

Developmental Stage/Event	Duration (yrs)	Example Activities
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Preforest	1 to 5+ (20+)	Site preparation; competition control; <b>Rx fire</b> ; regeneration
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**Goals:**  
-Restore/sustain old stage conditions

**You can't do that...emulate a natural model..**

20

**Emulating a Natural Model – You can't do that!  
...It puts regeneration in proximity to overstory pines**

**Impacts to survival/growth of intolerant species  
Red Pine, Jack Pine**

**Sunken Lake**

- Red Pine 1770
- Red Pine 1854
- Red Pine 1903
- White pine (all)

Northing (m)

Easting (m)

Uncut Stand

Aggregate Retention

21

**But you can do that!**

**Regenerating pine with retention...also shrub reduction!**

Aggregated: 0.75 ac gap

Aggregated: 0.25 ac gap

Dispersed

Uncut

Legend

15 yr Planted Pine Density w and w/o shrubs

TREES PER ACRE

Ambient Reduced Ambient Reduced

Uncut ~200 ft<sup>2</sup>/ac

Aggregate Retention-Lg Gap ~72 ft<sup>2</sup>/ac

Red Pine

Jack Pine

White Pine

Montgomery et al. Ecology 2010; FEM 2013

Palik et al. Eco. App. 2014

**Myth Busted:**  
Jack pine is shade intolerant...it's dry soil intolerant...tolerates moderate shade

Jack Pine Diameter

Red Pine

Diameter (inches)

Control Aggregate/Lg. Gap

Treatment

Shrub Retention

Shrub Reduction

How were shrubs controlled naturally?

22

**You can't do that? Overstory retention, shoot blight, and pine regeneration**

***Diplodia pinea*  
*Sirococcus conigenus***

**All pines susceptible, especially red pine**

**Myth Busted:**  
The threat of shoot blight means you can never use retention/multi-cohort stands

15 yr Planted Pine Density w and w/o shrubs

TREES PER ACRE

Ambient Reduced Ambient Reduced

Uncut ~200 ft<sup>2</sup>/ac

Aggregate Retention-Lg Gap ~72 ft<sup>2</sup>/ac

Red Pine

Jack Pine

White Pine

**There are things you can do to reduce impact:**

- Retention with larger openings...e.g., 1/2-3/4 ac
- Shrub reduction...lower humidity, less moisture stress

**-Rx fire? Kills spores, reduces humidity**

Ostry et al. FEM 2012

**if you think I am dwelling on the past...consider climate adaptation**

23

**Ecological Silviculture can be Adaptation Silviculture** D'Amato and Palik. *CJFR*. 2021

ASCC [www.adaptivesilviculture.org](http://www.adaptivesilviculture.org)

Muller et al. FEM 2019

Palik et al. *Ecosphere*. 2022

Wiechmann et al. FEM 2022

Muller et al. *CJFR* 2021

Red Pine ASCC

Cutthroat Experimental Forest

Warmer in all seasons  
Drier growing season

Nagel et al. *J. of For.* 2017

**Fire-Dependent Mixed-Species-Red Pine Woodland**

Promote change

Maintain conditions

Reduce impacts

Facilitate adaptation

Adapted genotypes and species, including novel species, within the context of a natural model...more oaks?

Transition

Resilience

Restore composition and structure...NIV; some species more adaptable...e. white pine, oaks, jack pine and complex structures are more stable to disturbance

Resistance

Manage to enhance resistance to a stress...drought...woodland structure

Role of Rx Fire?...greater opportunities?

24

**Summary**

- Red pine dominated woodlands were much different structurally and compositionally than their managed counterparts...historically....mixed-species, lower stocking, variably open canopy, complex age structures
- Fire was key to dynamics and structure...but in ways that have not been fully appreciated until recently
- Silviculture for this ecosystem has rarely emulated the natural model...but it can
- Such a model combines a variety of approaches...variable density thinning, variable retention harvesting, enrichment regeneration, and Rx fire at multiple developmental points
- A natural model, including one that better embraces Rx fire, does not eliminate timber objectives...although what you grow and how you grow it will change
- A natural model can be adaptable to changing climate

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