Great Lakes Red Pine Forest: A Fire-Dependent Ecosystem in Transition

What do we think we know? What we really know? What we need to know?

- **Review: *Great Lakes Mixed Pine***
- **Misconceptions and threats**
- **Management lessons**

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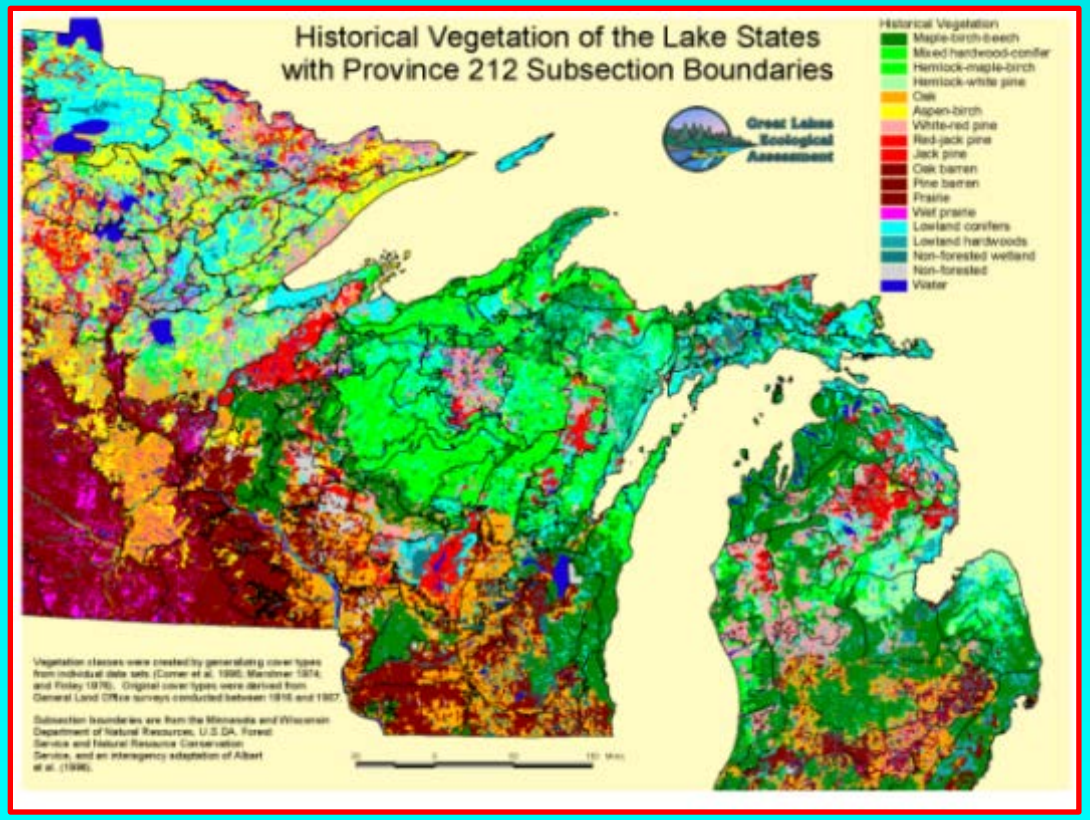
Laurentian-Acadian Northern Pine-(Oak) Forest



MN: Northern Dry-Mesic Mixed Woodland

MI: Dry Northern Forest

Importance:
- -Iconic regional forest type
- -High value products (sawlogs, poles, cabin logs)

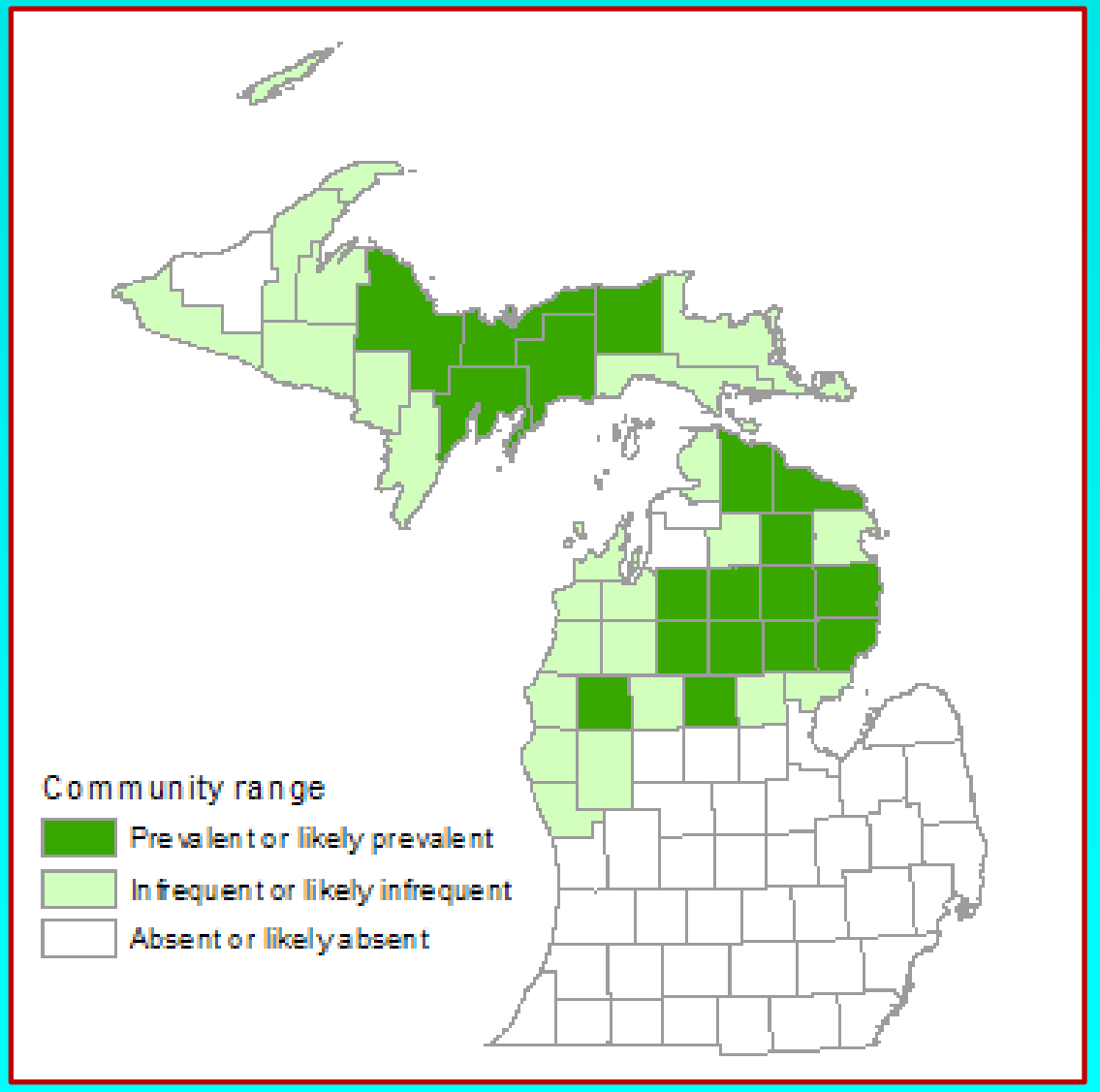
Loss of area:
- -Historical: ~4 million ha
- -Contemporary: < 750,000 ha

Simplification of structure/composition:
- -Red pine plantations
- -Conversion to oak or aspen dominance

In Northern Michigan:

Dry Northern Forest

-Red pine
-Paper birch
-Red maple
-Bigtooth aspen
-Balsam fir
-Northern red oak
-Eastern white pine



What do we think we know about this forest type?

1. Fire dependent:

Yes, but…

2. Even-aged: red pine establishing after replacement fire

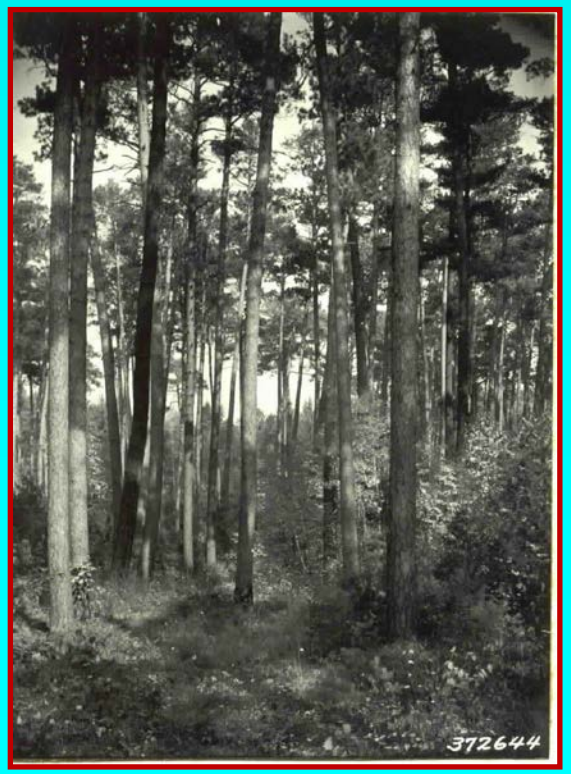
Not this simple

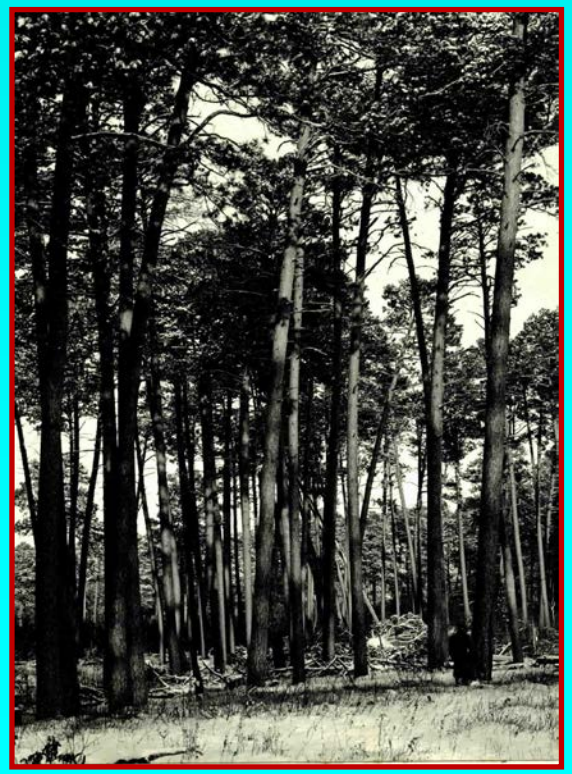
3. Near mono-specific: red pine dominated

Not usually

4. Well adapted to xeric, drought prone sites

Adapted, but still vulnerable





Premise:
We need to understand these issues and address them, given vulnerabilities of this forest to lack of fire and climate change

Natural Fire Regime: Classic Model

MN: Northern Dry-Mesic Mixed Woodland

-Infrequent catastrophic fire rotation of 220 years

-Frequent, low-intensity surface fires, w/ rotation of 75 years

MI: Dry Northern Forest

-Infrequent catastrophic fire return interval 120 to 300 years

-Surface fires with return intervals ranging from 5 to 20 years

Heinselman (1996): return interval (yrs)

-Crown fire: 150-250

-Surface fire: 5-50

General interpretation: infrequent stand replacing crown fire w/ frequent stand maintaining surface fire

But…

There has always been the suggestion that *fires were less-than-stand-replacing,* as inferred from the occurrence of structurally complex stands

(Bergman 1924, Shirely 1932, Eyre and Zehngraff 1948)

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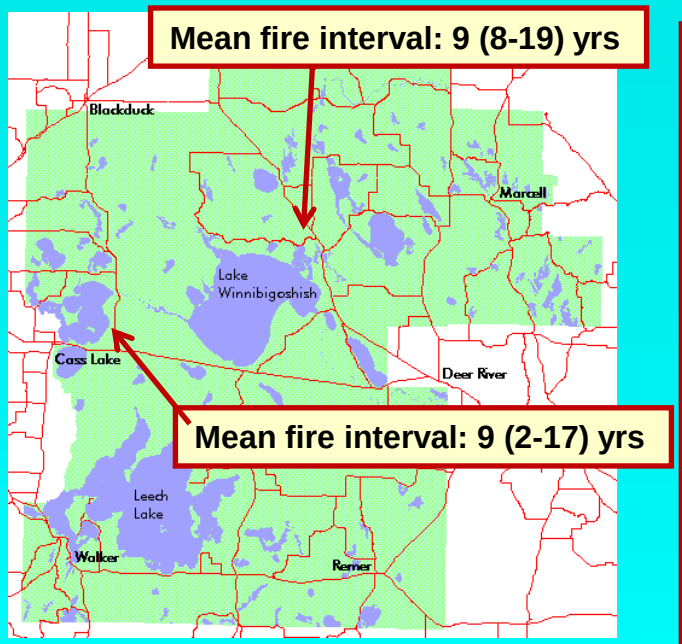
FIGURE 1.—Typical virgin Norway pine stand, with young Norway reproduction in the openings. These saplings are about 18 years old and 4 to 5 feet high

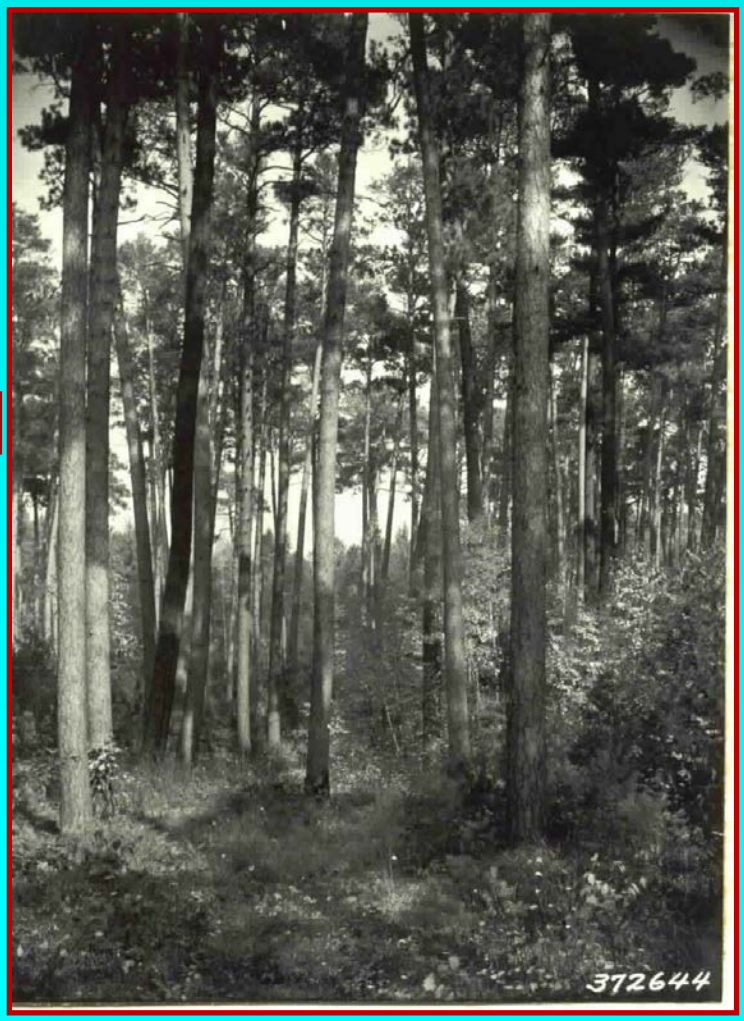
“Typical virgin Norway pine stand with young Norway reproduction in openings”

Moreover:

Fire was likely more frequent than the Heinselman model suggests

Guyette et al. unpublished





Chippewa National Forest:

-Frequent fire: MFI 9 years

-Most surface, but occasionally crowning

-Patchy/Heterogeneous

So yes, a fire-dependent ecosystem, but perhaps in a different way than we often think:

Very frequent surface fire; infrequent partial canopy disturbing fire

True stand replacement event perhaps not the norm

Fire was patchy with resultant patchy canopy structure

Management rarely emulates this disturbance dynamic

-Rx surface seems rare:

2006-10 MN DNR averaged 1,452 ha of prescribed burning in forests

-Stands often not managed for complex structure; even-aged management is the norm

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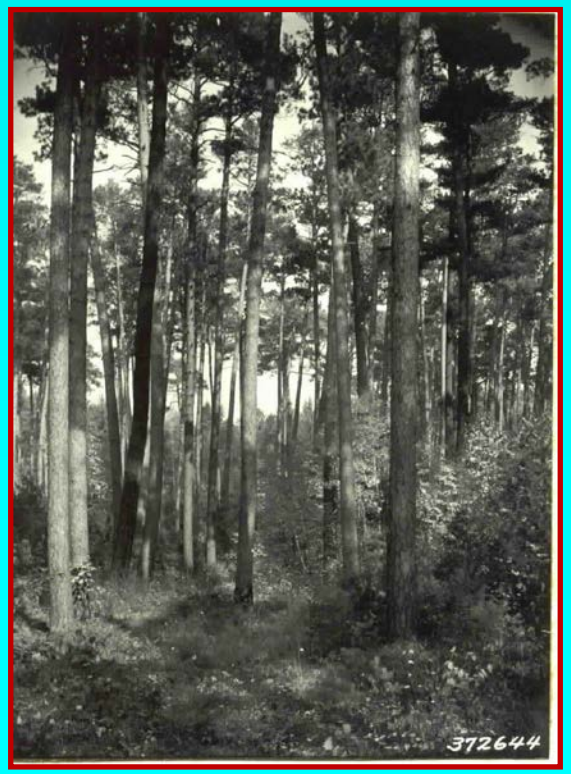

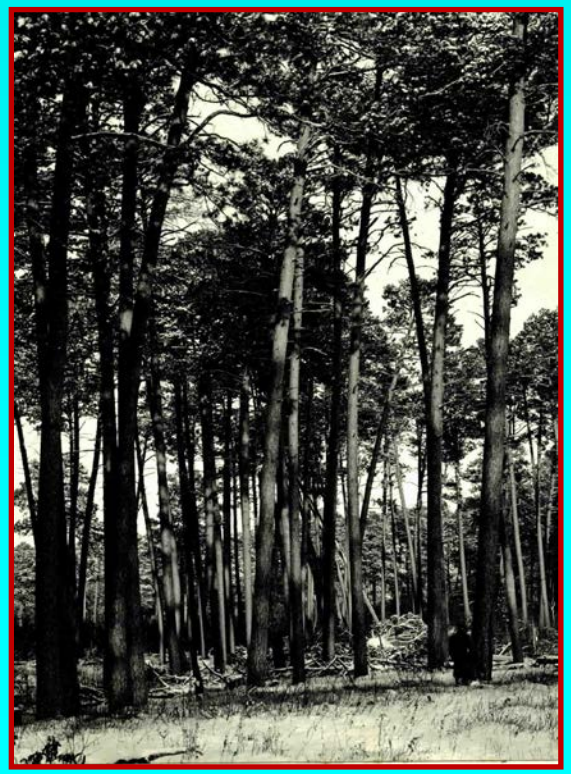

Complex Age Structure:

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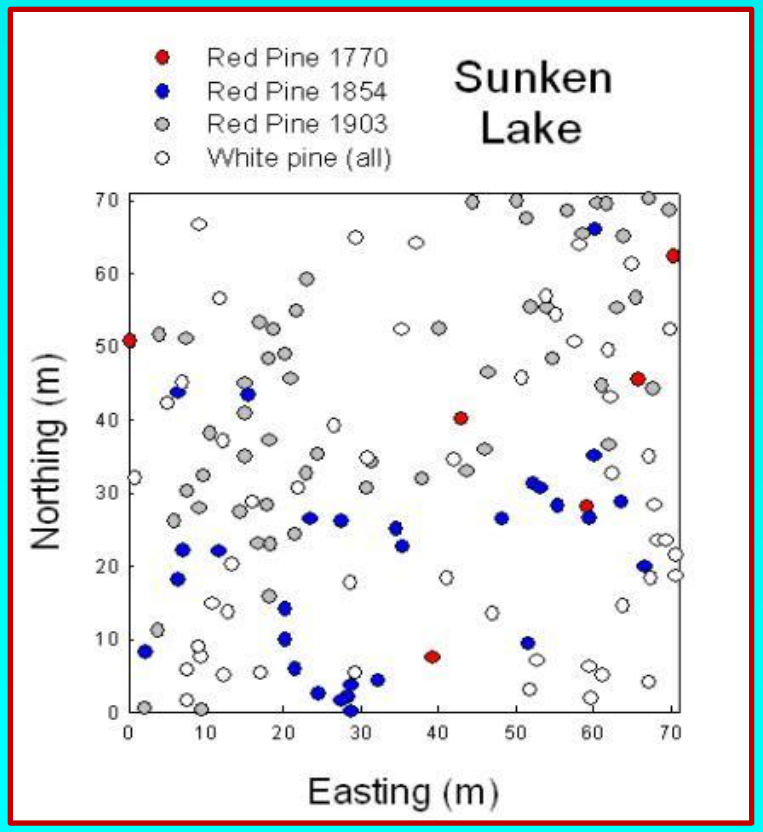
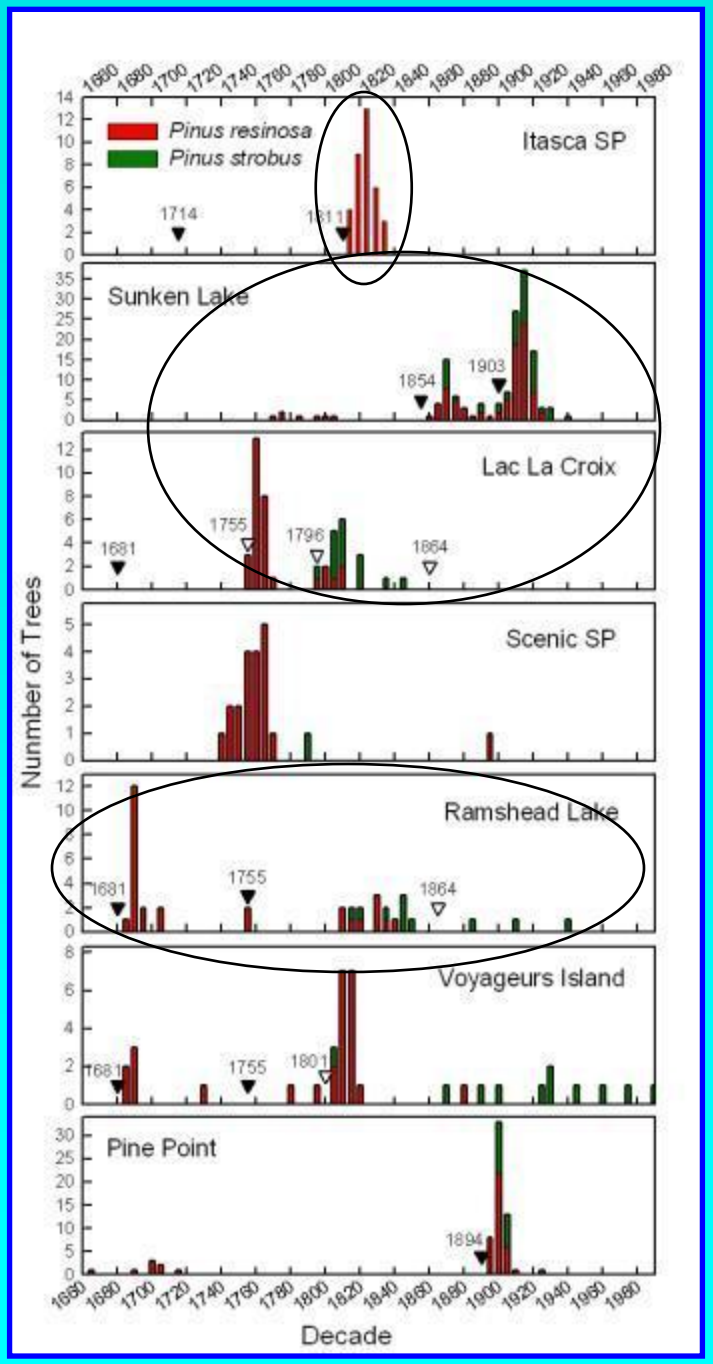
FIGURE 1.—Typical virgin Norway pine stand, with young Norway reproduction in the openings. These saplings are about 18 years old and 4 to 5 feet high

“Typical virgin Norway pine stand with young Norway reproduction in openings”

Recent research supports that these forests could have complex disturbance dynamics and structure

- -Single-cohort stands (broadly)
- -Two- and three-cohort stands
- -Regeneration in openings
- -Structurally complex-heterogeneous





Yet management is very much single-cohort (narrowly even-aged) focused

Typical management sequence:

Year 0:	**Clearcut harvest (typically)**
Year 1:	**Herbicide or mechanical site prep-growing season (Mechanical site preparation in the fall)**
Year 2:	**Plant in the spring 600-800 trees/ac**
Year 2-4:	**Bud cap in fall**
Year 4-5:	**Herbicide or mechanical release**
Year 30:	**First thinning (every 15 years thereafter)**
Year 60-120:	**Final harvest**
Replant	

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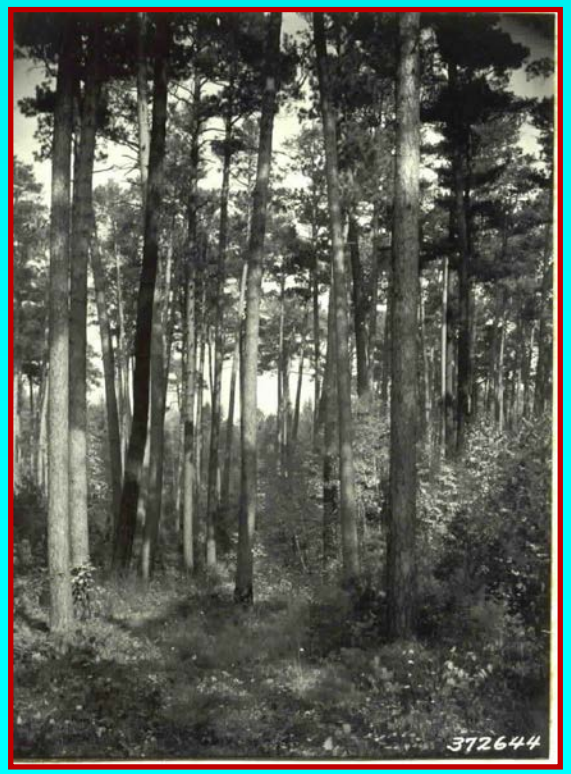
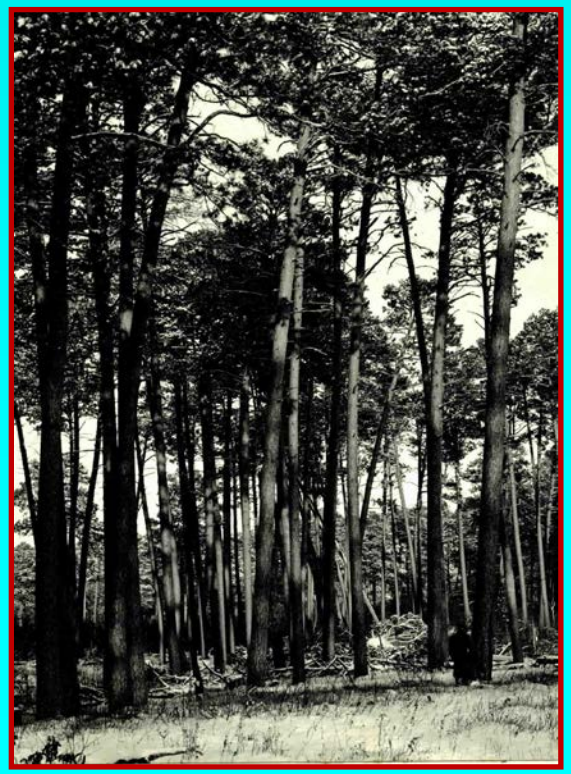
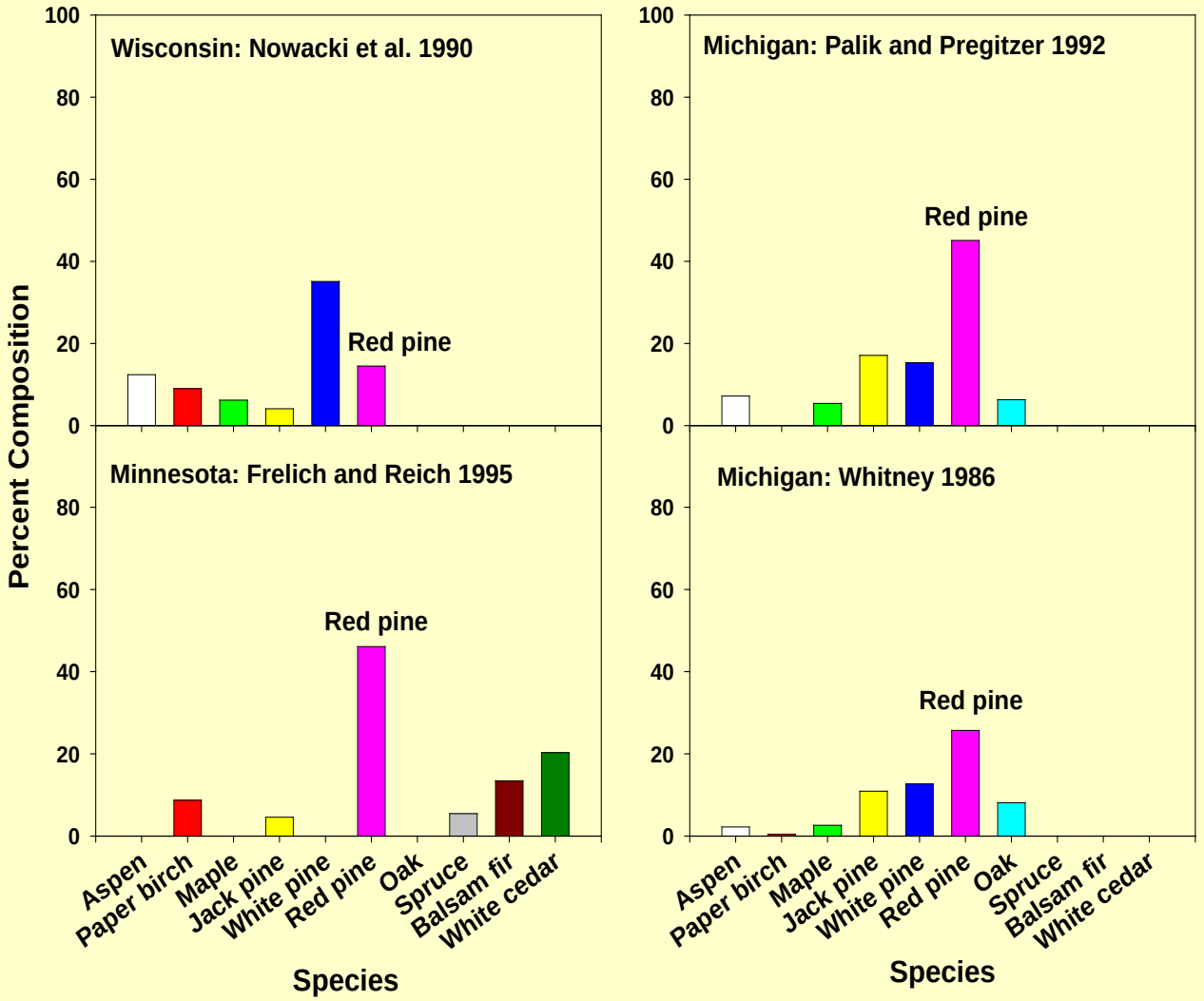




Other species were important in red pine stands historically



-Mixed-species stands

-Canopy & sub-canopy

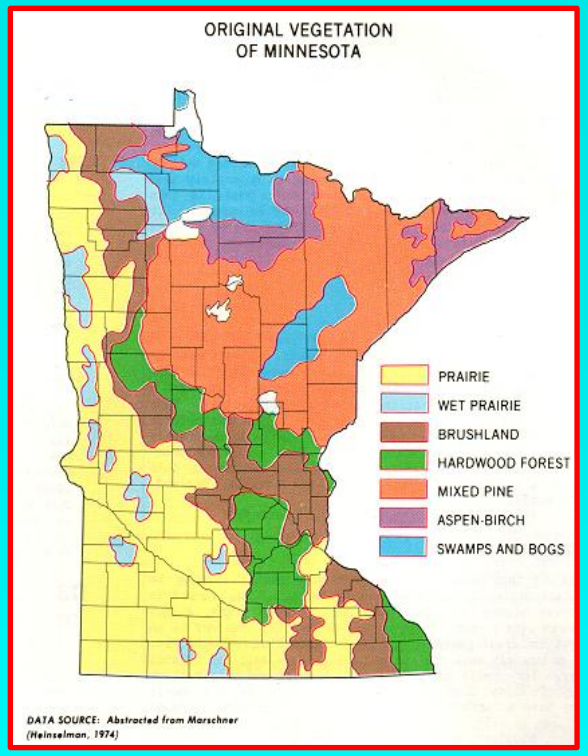
-Equal to or greater importance than red pine

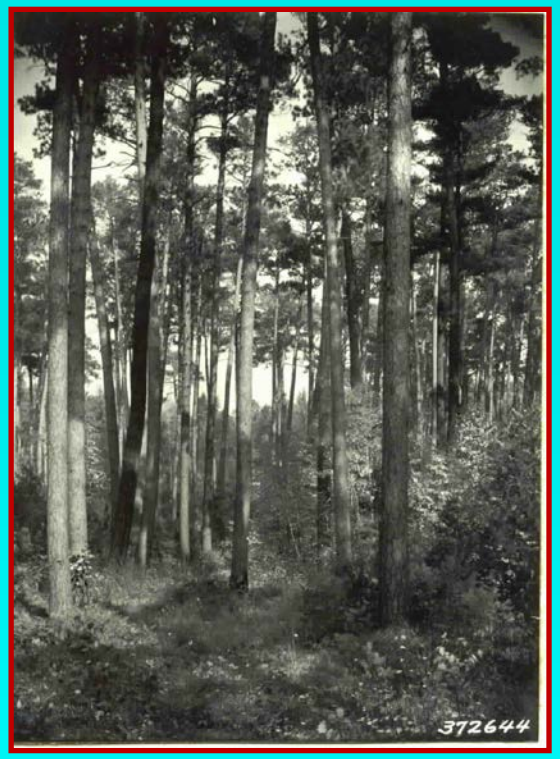
-Again, suggests that disturbances were patchy and partial

In Northern Minnesota:

Northern Dry-Mesic Mixed Woodland (FDn33a)

- -Red pine
- -White pine
- -Paper birch
- -Trembling aspen
- -Red maple
- -Jack pine
- -Bigtooth aspen
- -Balsam fir
- -Northern red oak
- -Bur oak
- -White spruce





Our plantation management for red pine is very much contrary to the natural model; i.e., single species, high density stands

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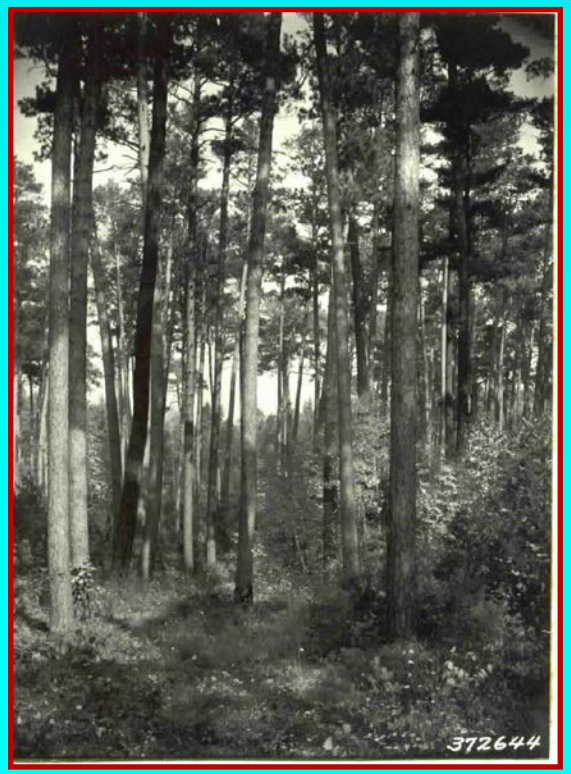

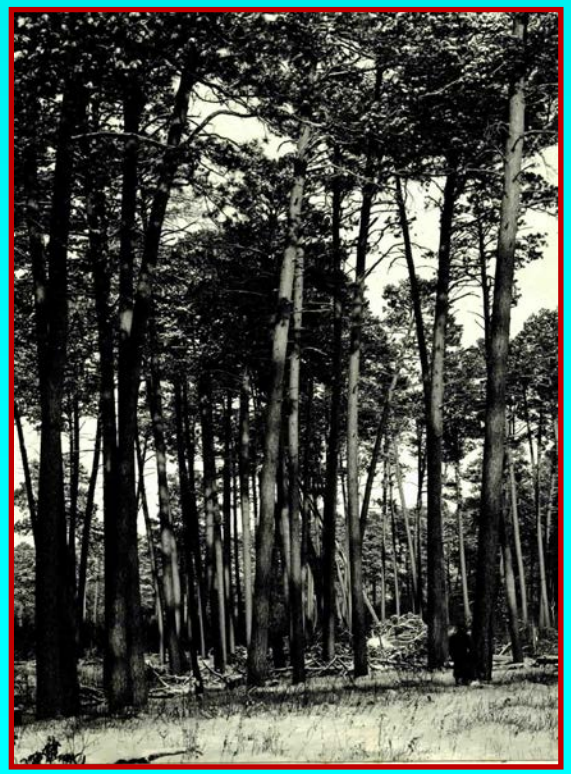

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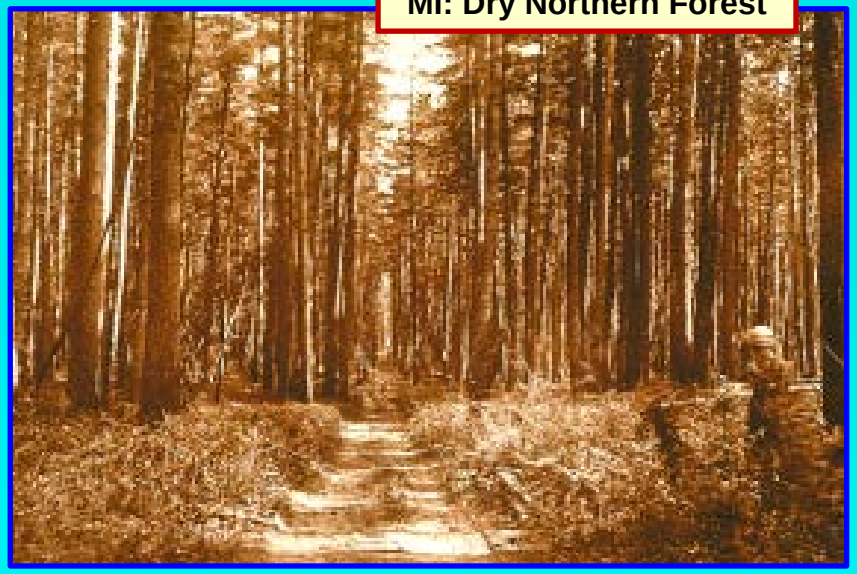


Adapted to xeric, drought prone sites: sandy soil on outwash, ice contact

Yes, but still susceptible to drought and projected climate change

What is the projection? Northern MI

Predicted by 2070-2099 (v. 1970-2000) *GFDLA1F1*

Temperature change:

+4.1º C average Winter

+6.2º C average Summer

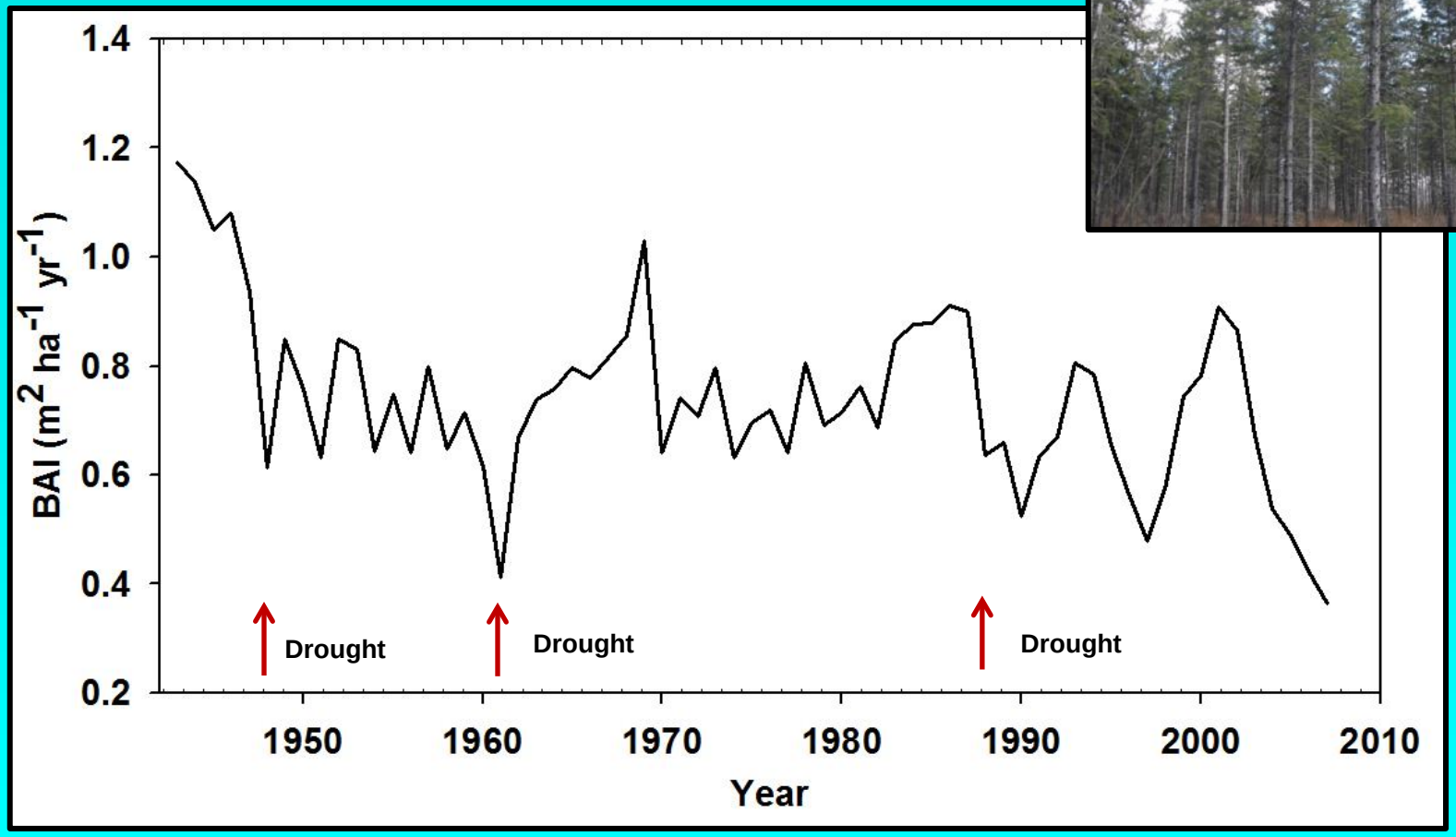
Precipitation change:

+2.5 cm average annual

-9.7 cm average Summer

More frequent and severe growing season drought

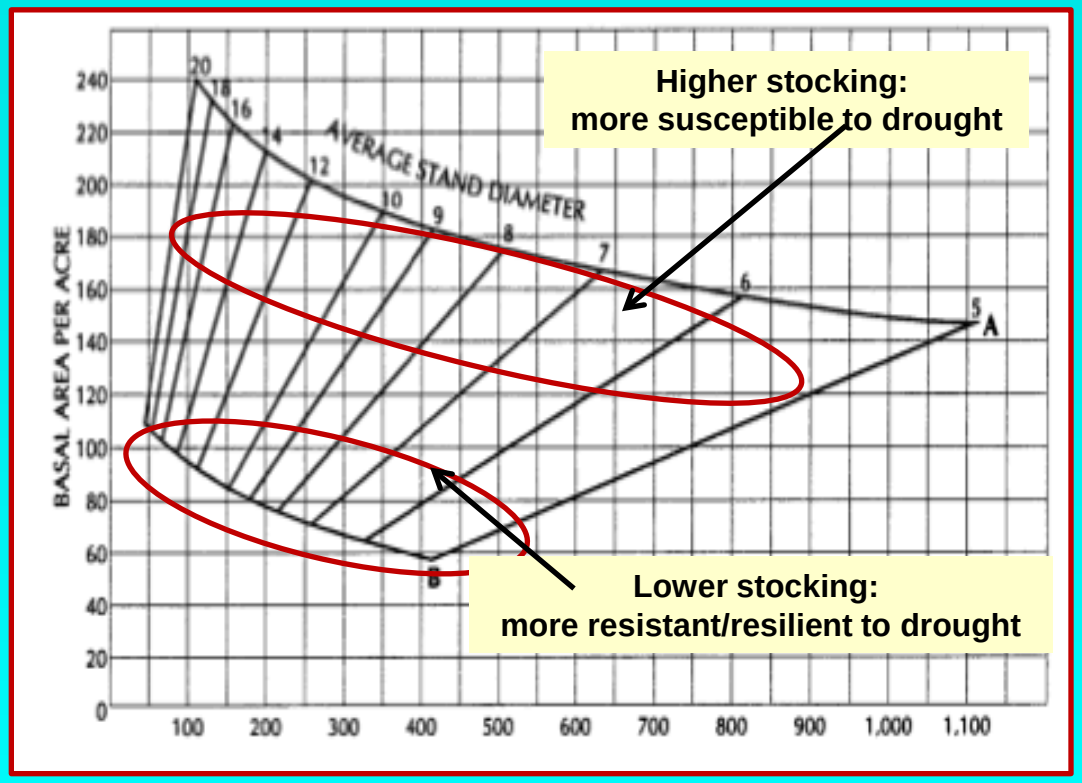
Drought impacts on red pine growth



However:

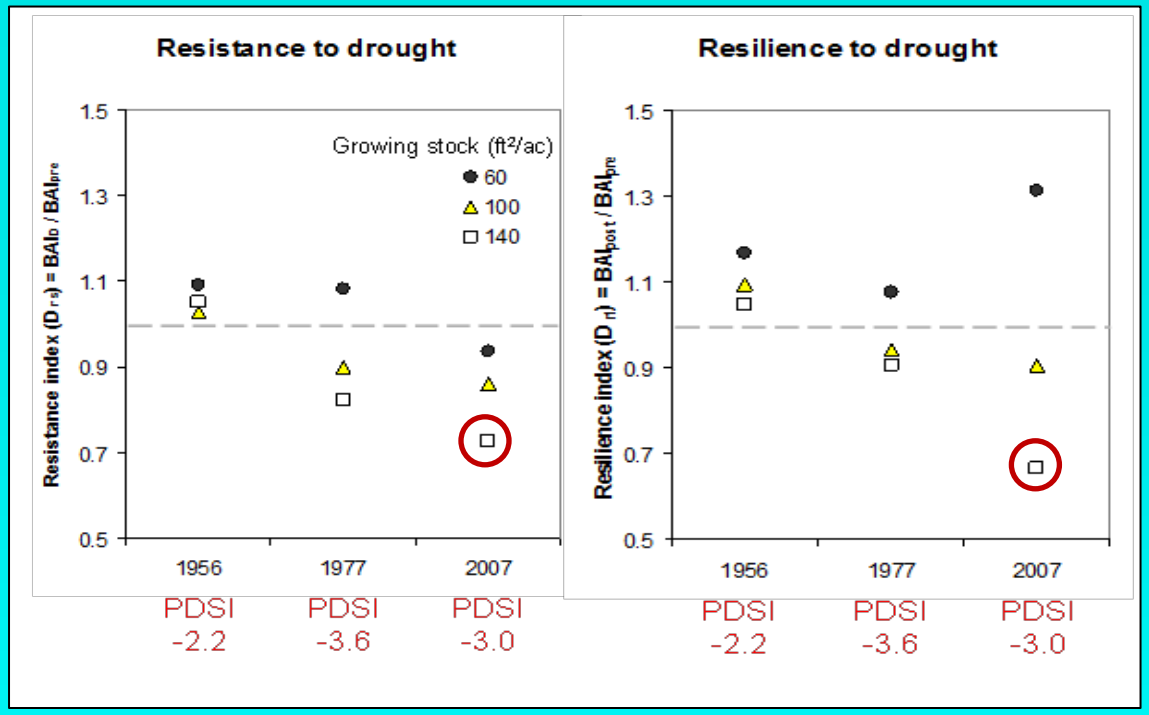
We know how to reduce impacts of drought on growth: density management

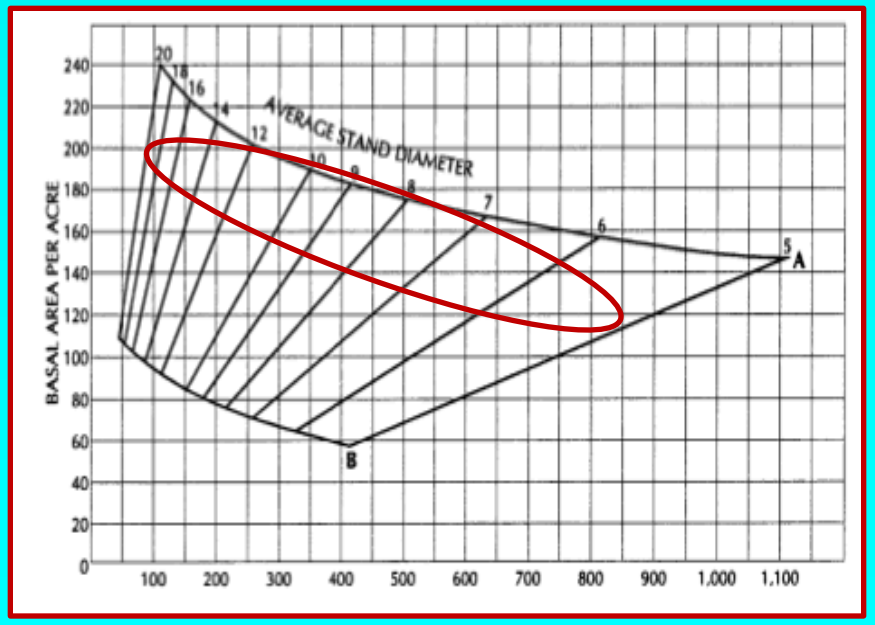
Stand Density



-Stands at the higher range of stocking are more susceptible to growth reduction during and after drought

-Stands at the lower range of stocking are more resistant and resilient to drought





Our management (especially plantations) for red pine exacerbates drought related growth reductions by managing at high stocking

Moreover:

Tree species habitat predictions w/ climate change

Mixed *Pine* Forests in Michigan
(Huron NF – Tree Atlas: change in IV

Reduced Habitat Suitability

Species	Current	HadHiDif
Trembling aspen	10.17	-9.82
Balsam fir	4.15	-3.82
Paper birch	2.58	-2.58
Jack pine	11.75	-9.04
Bigtooth aspen	6.48	-5.59
Eastern white pine	3.60	-2.53
Red pine	8.14	-7.11
Northern red oak	8.36	-5.44

Increased Habitat Suitability

Species	Current	HadHiDif
Black oak	2.26	4.71
White oak	2.39	3.46

In summary:

An ecosystem in transition due to altered fire, timber focus, climate change

Messages for management:

1. *Red pine dominated forests were likely even more fire dependent when we generally think; but how often is Rx fire used regionally?*
2. *Stand structures were complex, variable, and patchy due to natural fire regime; not even-aged and dense*
3. *A combination of Rx fire and variable retention harvesting can emulate natural dynamics; our management runs counter to this*
4. *Mixed-species woodlands were more the norm; vs single species stands maintained at high stocking*
5. *Managing at lower stocking can reduce drought impacts on growth; but not so low as to compromise productivity*
6. *Rx fire has an even more important role w/ climate change; can reduce stocking and increase drought adaptation (near-term), facilitate transition to future climate and fire adapted species (longer-term)*

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