Rehabilitating Disturbed Forests

Where We Stand And What We Need

A Webinar Presentation For

USDA - NRSC

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Some definitions …

Forestry –
- **using science, art, and common sense to create, manage, use, and conserve forests and their resources**

Forest management –
- **applying the art and science of forestry to a forest property to satisfy the goals while maintaining its productivity**

Silviculture –
- **the methods for controlling establishment, growth, composition, and quality of forest stands**

… all for sustained human benefit

And in the context of ecosystem management …

… creating, maintaining, and reestablishing desirable ecosystem conditions

… and using stand-level treatments to sustain critical conditions at a landscape scale

… as an aftermath and in the process

… we derive values, commodities, and uses

Today we focus on silviculture …

… the ways we manage a *stand*

***Stand* …**

… the part of a forest we treat by a timber sale or other management activity

… an area of forest to manage by a single operation

But silviculture has two real purposes:

- to regenerate mature age classes

- to tend immature age classes

We use timber harvesting

and tree cutting as …

… a means

to accomplish these purposes

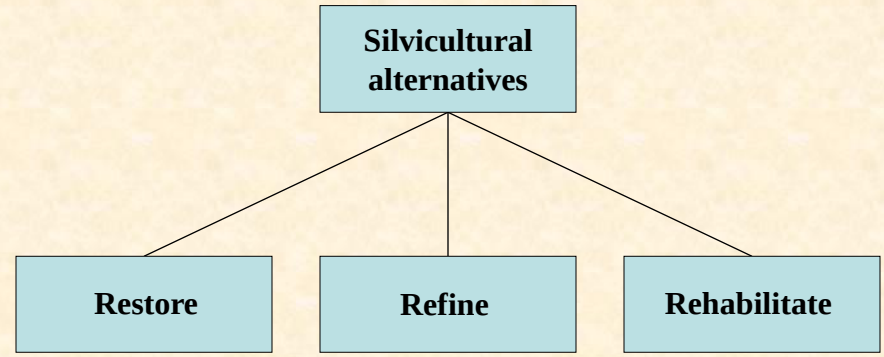
So consider silviculture …

… drawn from a huge tool bag of methods for sustaining the values of interest

… for regeneration

… for tending

… to serve a landowner's interests

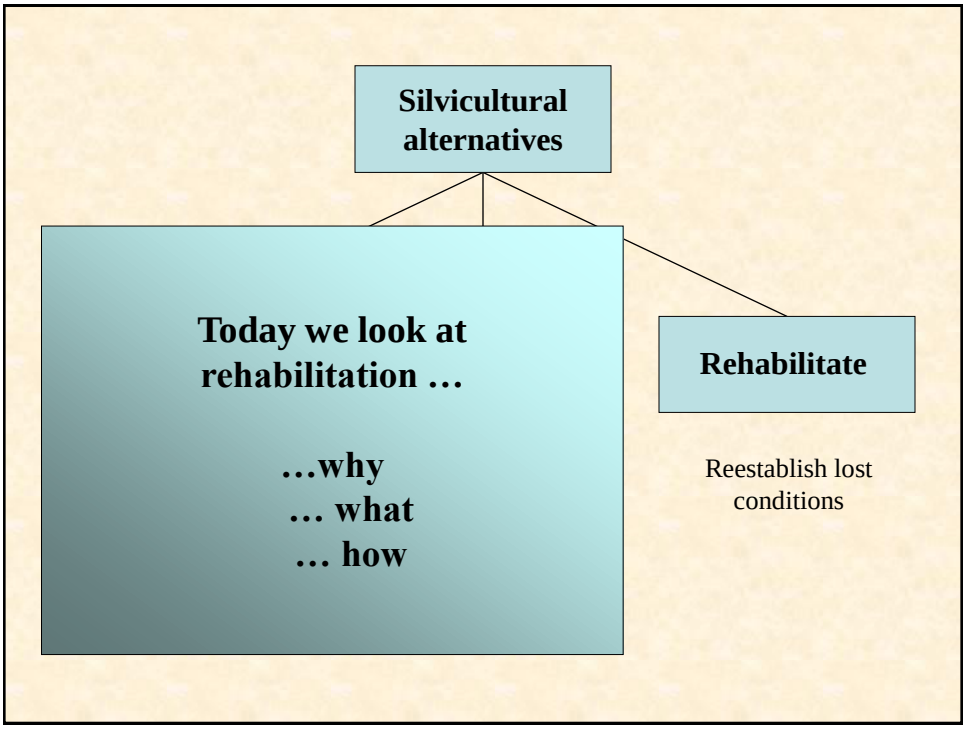


Return to an original state

Improve and sustain existing conditions

Reestablish lost conditions

Based on ideas from Jean-Martin Lussier, Laura Kenefic, Patricia Raymond, Catherine Larouche, Steve Bedard, Stephane Tremblay, and Ralph D. Nyland. 22 June 2012



Rehabilitation …

… using ecologically acceptable methods to reestablish desirable conditions after an uncontrolled disturbance

… consistent with a landowner's objectives

Based on discussions by Catherine Larouche, Laura Kenefic, Patricia Raymond, Steve Bedard, Jean-Martin Lussier, Stephane Tremblay, and Ralph D. Nyland.
22 June 2012

Based on that …

… several natural and people-caused disturbances leave conditions that warrant rehabilitation

As examples …

… snow and ice loading, and wind storms
… fire causing partial mortality
… damage by insects and diseases
… cutting practices

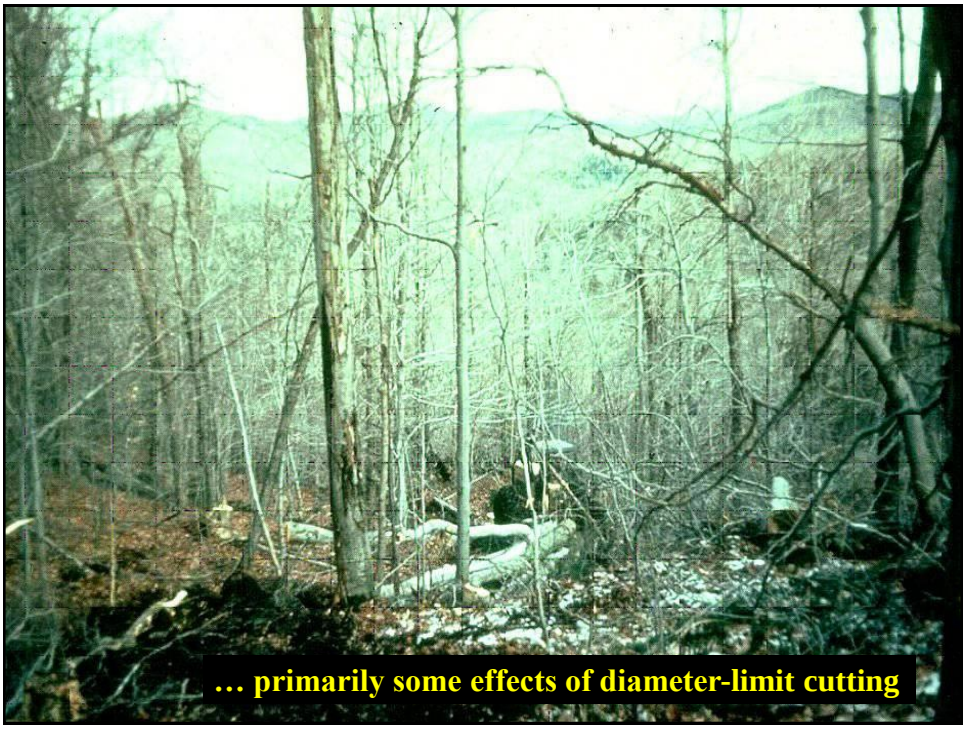
… ongoing and never ending

Note this about …

… diameter-limit cutting

… an uncontrolled disturbance from a silvicultural perspective

… let's use exploitive cutting to explore stand rehabilitation



And ask …

How much diameter-limit cutting
or some other exploitive harvesting …

… compared to silviculture

And what does it leave behind …

… compared to silviculture

Using New York State as an example for Northeastern North America…

NY Society of American Foresters wanted to know about common timber harvesting …

… so it sampled recently cut stands across the state

In the mid-1990's …

And looked at …

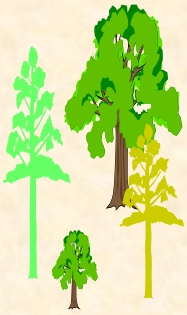
-- residual stocking (basal area/acre)

-- variation of residual stocking

-- retention of desirable species

-- change in average tree diameter

-- change in sawtimber potential



… in combination

First assigning a rating to each of the five measured stand characteristics …

… on a scale of 1 to 3:

1 = Good

2 = Mediocre

3 = Bad

… based on objective decision criteria for assigning points

… in increments of 0.1 points

NY SOCIETY OF AMERICAN FORESTERS
RESIDUAL STAND EVALUATION CRITERIA

1. **Amount of residual basal area left following cutting.**

___ Less than 10 ft²/ac -- this condition identifies clearcuts, shelterwood removal cuts, and some liberation cuts

If so, STOP EVALUATION…

2. **Variability of basal area not increased substantially.**

___ 1 = Good conditions -- Coef. var. <30%, and CV increases <1.50 times
___ 2 = Mixed conditions -- Coef. var. <30%, and CV increases <1.51 to 1.99 times
___ 3 = Poor conditions -- Coef. var. >30%, and CV increases at least 2.0 times

3. **At least 60% of the basal area retained.**

___ 1 = Good conditions -- the residual/pre-cut ratio at least 0.60
___ 2 = Mixed conditions -- the residual/pre-cut ratio between 0.59 and 0.51
___ 3 = Poor conditions -- the residual/pre-cut ratio <0.50

4. **Appreciable stocking of prime species left**

___ 1 = Good conditions -- Acceptable species reduced <6%; Unacceptable ones increased <6%
___ 2 = Mixed conditions -- Acceptable species reduced 6 - 9%; Unacceptable ones increased 6 - 9%
___ 3 = Poor conditions -- Acceptable species reduced 10% +; Unacceptable ones increased 10%+

5. **Appreciable stocking of large trees left**

___ 1 = Good conditions -- QSD reduced <0.25 inch, up to 35% of ST cut
___ 2 = Mixed conditions -- QSD reduced 0.25 to 0.50 inches, 36 – 45% of ST cut
___ 3 = Poor conditions -- QSD reduced >0.50 inches, 46% + of ST cut

6. **Appreciable stocking of AGS left.**

___ 1 = Good conditions -- AGS >60% of total BA, >70% of ST*, >70% of 6"+**
___ 2 = Mixed conditions -- AGS 50 – 59% of total, >60% of ST*, >60% of 6"+**
___ 3 = Poor conditions -- AGS <50% of total, <60% of ST*, <60% of 6"+**

* For stands with at least 30 ft²/ac of ST

** For stands with 20 – 29 ft²/ac of ST

Nyland – 1998

Then rating each stand using a composite index that averaged these five measured stand characteristics …

… on a scale of 1 to 3:

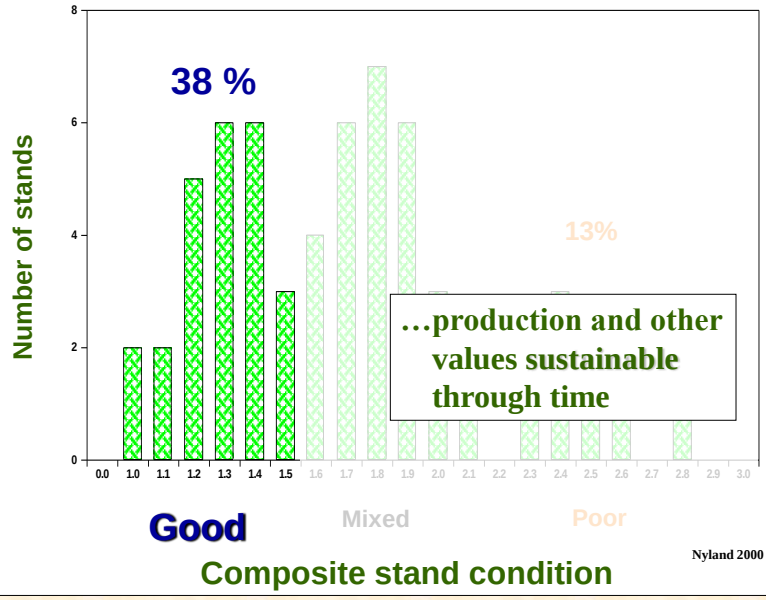
1 = Good

2 = Mediocre

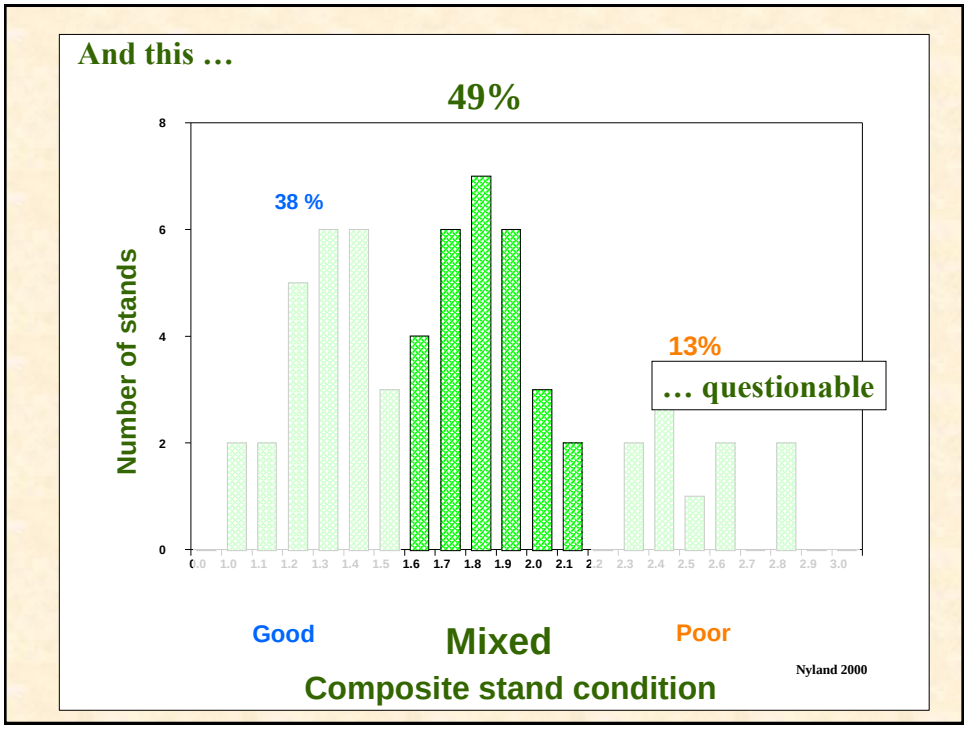
3 = Bad

… also in increments of 0.1 points

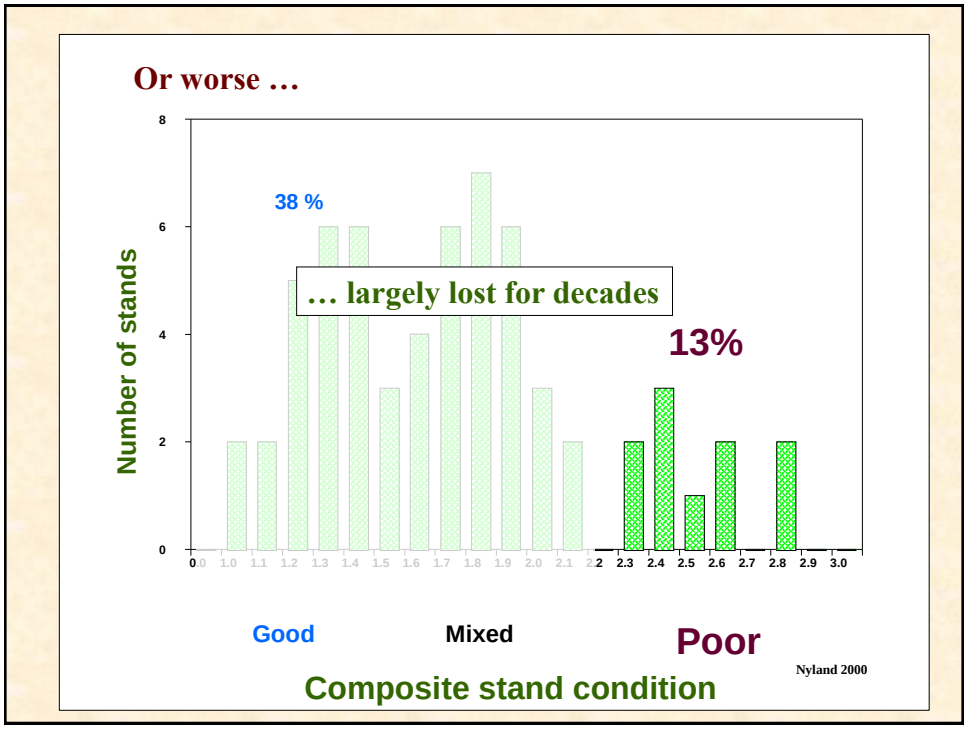
We found …




GOOD
… a high potential
… sustaining many values


And this …
49%
38 %
13%
… questionable
Number of stands
0
2
4
6
8
0.0 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0
Good
Mixed
Poor
Composite stand condition
Nyland 2000


MEDIOCRE
… silvicultural purgatory
… with some hope


Or worse …
Number of stands
0
2
4
6
8
38 %
… largely lost for decades
13%
0.0 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0
Good
Mixed
Poor
Nyland 2000
Composite stand condition


RAVAGED
… degraded and dismal
…. with little future potential


RAVAGED
… commonly among stands after two diameter-limit cuts

More recent surveys in NY, PA, KY, and WV had the similar findings …

… diameter-limit and other exploitative cuts most common

Pell (1998) in Pennsylvania …
… *questioned the potential* for long-term sustainability

Fajvan (1998) in West Virginia …
… all but a few *not sustainable*

McGill et al. (2004) in West Virginia …
… diameter-limit cutting the *most severe* practice

Munsell and Germain (2007) in New York …
… essentially *mediocre* and *not sustainable*

Schuler and McGill (2007) in Appalachian region …
…diameter-limit cutting *depleted* quality sawlog resources

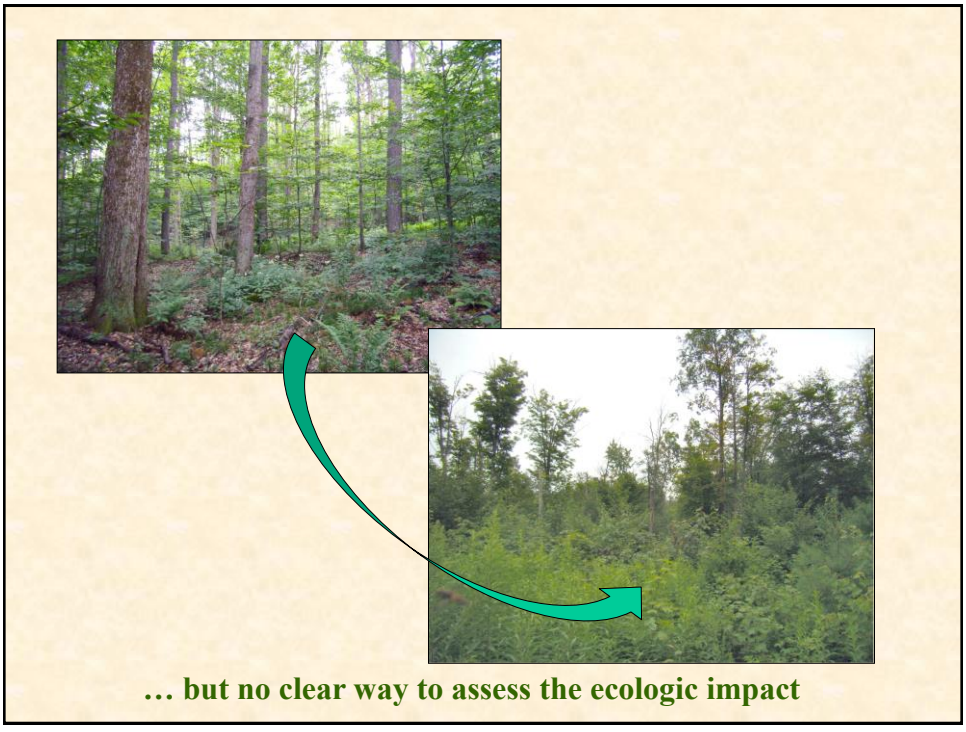
Stringer (2008) in Kentucky …
… 72% of stands *degraded* by exploitive cutting

Munsell et al. (2009) in New York …
… diameter-limit and premature cutting *pervasive*


Is this Forestry ?


… or the green lie


With value and production potential lost and long gone …
P. Nyland - 2010
… like closing the door after the sheep got out


… but no clear way to assess the ecologic impact

So …

- how did cutting change stand conditions

- do residual conditions dictate or limit the treatment options

First, what do we mean by …

… even-aged

… uneven-aged

… two-aged

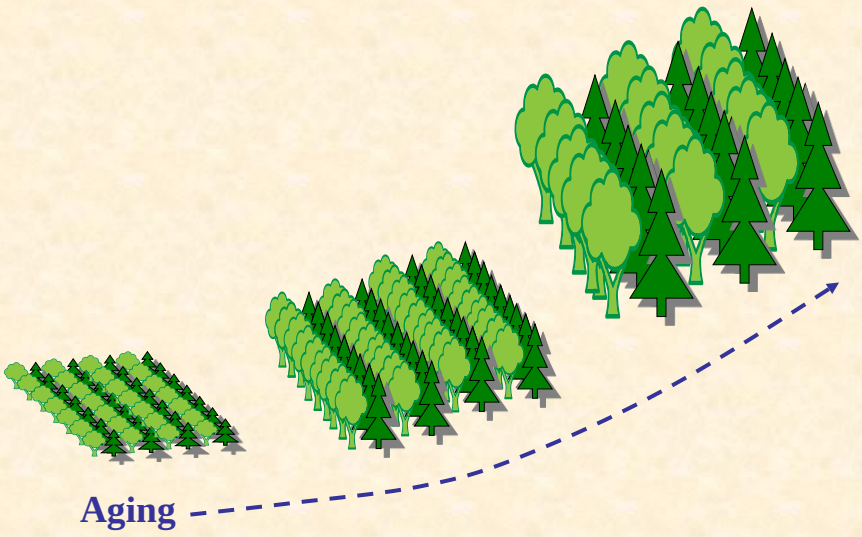
EVEN-AGED

A community of trees having no or only small differences in ages …

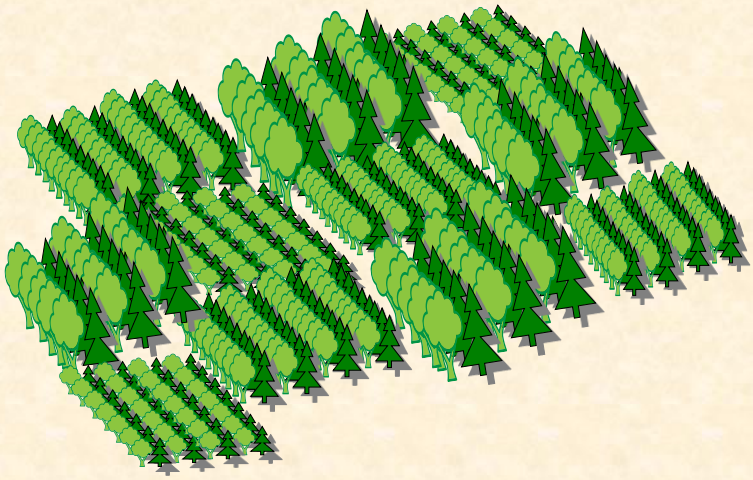
… by convention with a spread of ages *not exceeding* 20% of the rotation length

ROTATION …

… the planned number of years between formation of a stand *(even-aged)* and its final cutting (*regeneration*) at a specified degree of maturity



… with a clear pattern of development through time
… within a single stand



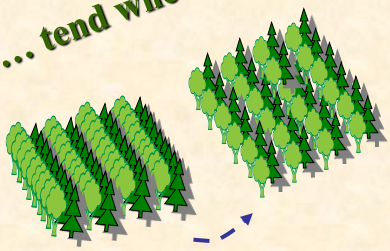
… and in each even-aged stand across a forest

So …

All trees in a stand regenerated at the same time …
… all developing to maturity together
… all coming of age at the same time

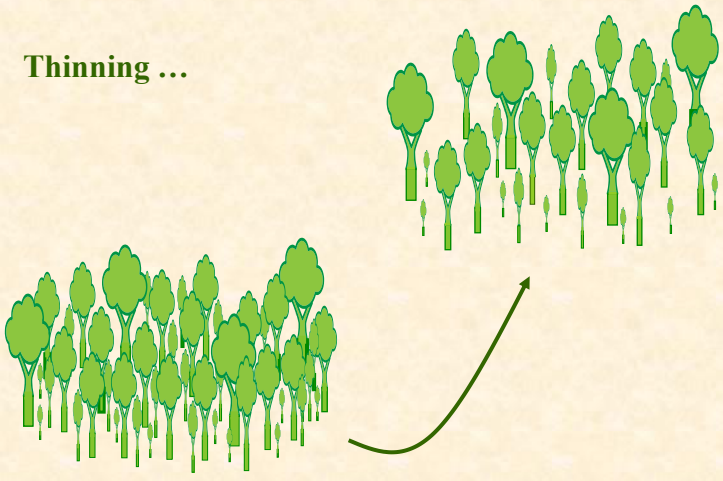
With even-aged stands …

… tend when immature



… reducing the crowding

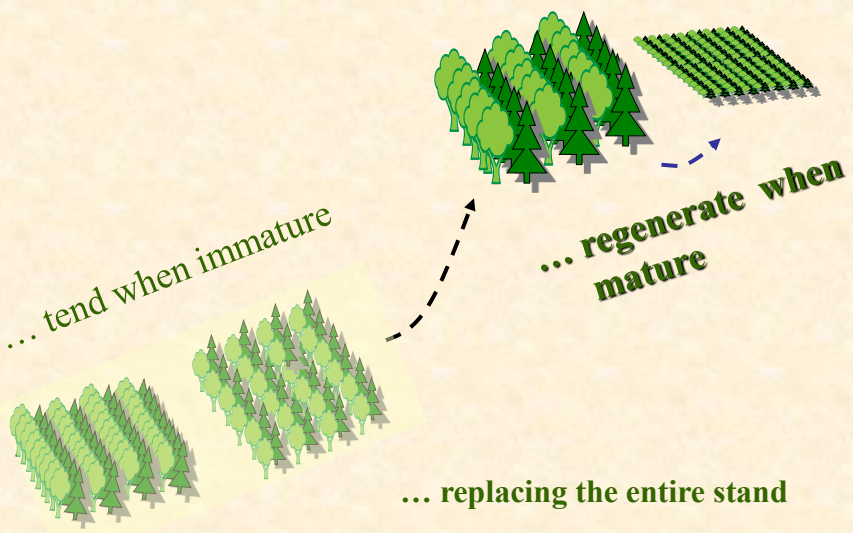
Thinning …



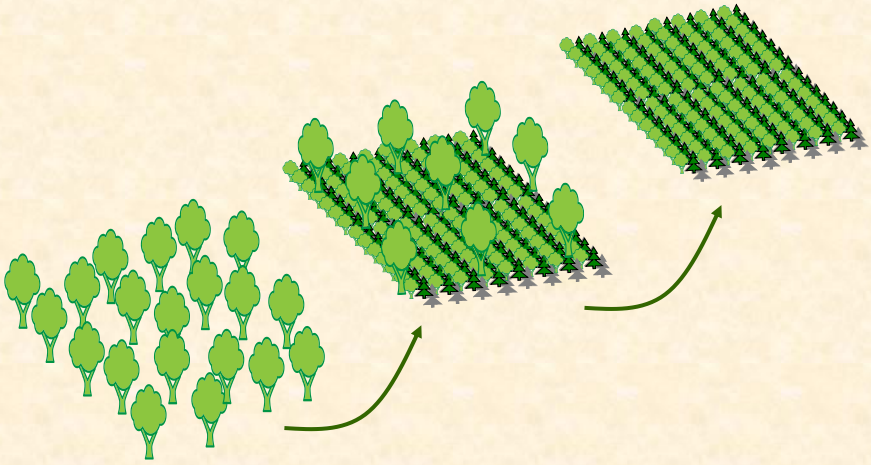
… favors the biggest and best trees to promote their growth

... with tending *(e.g., thinning)* to influence stand development

With even-aged stands …



… like the shelterwood method



… when an even-aged stand matures

One kind of
even-aged regeneration
method …

UNEVEN-AGED

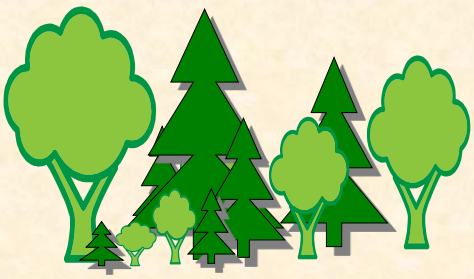
A community with trees that differ markedly in their ages …

… by convention the spread of ages

exceeds 25% of the planned lifespan

for an age class

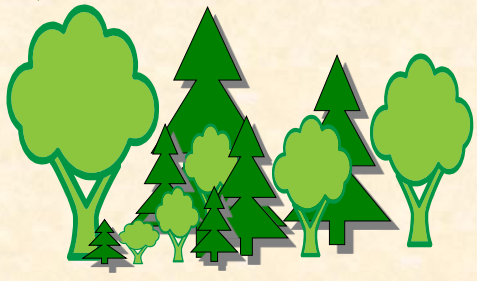
… each stand having trees of different ages

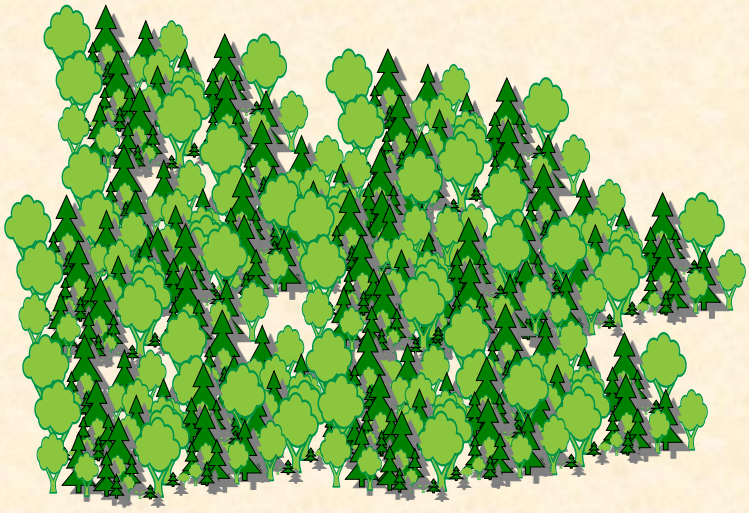


… all growing together in the same stand

… with ages and sizes interspersed across a stand

… but only one age class
reaching maturity at a time



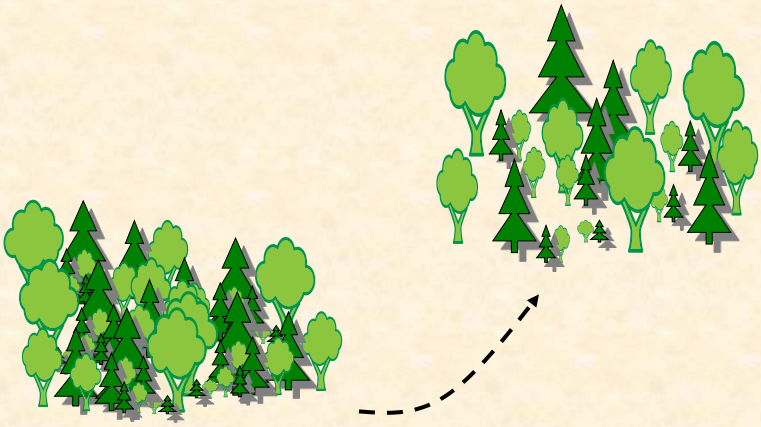


… likewise in uneven-aged stands across a forest

So …

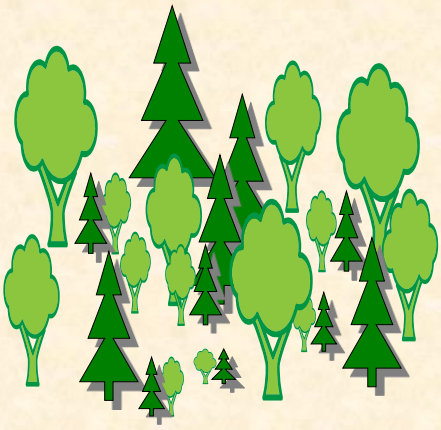
Parts regenerated at different times …
… young, middle-aged, and old all present
… each comes of age at a different time

With uneven-aged stands …



… both tend and regenerate each time

Periodically …



… regenerating the mature trees

… AND thinning the younger age classes

SELECTION METHOD

... the uneven-aged

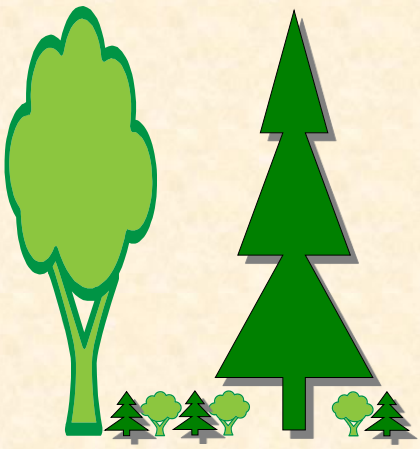
regeneration method

... *coupled* with tending of the three or more age classes within a stand

TWO-AGED

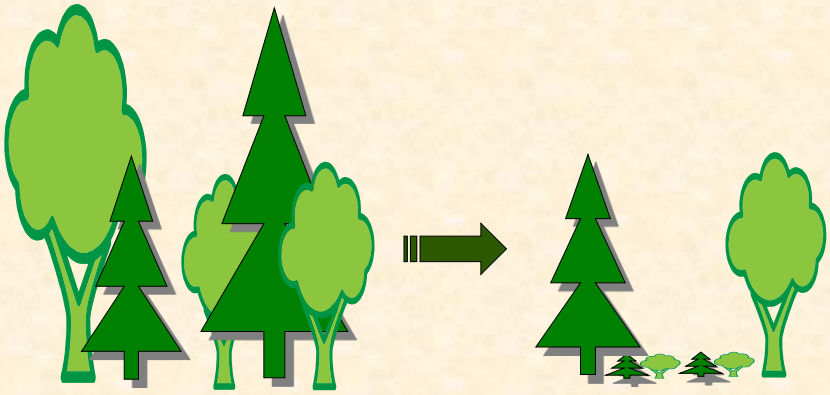
A community with trees of two distinct age classes …

… separated in age by *more than* 20% of the life span for each one



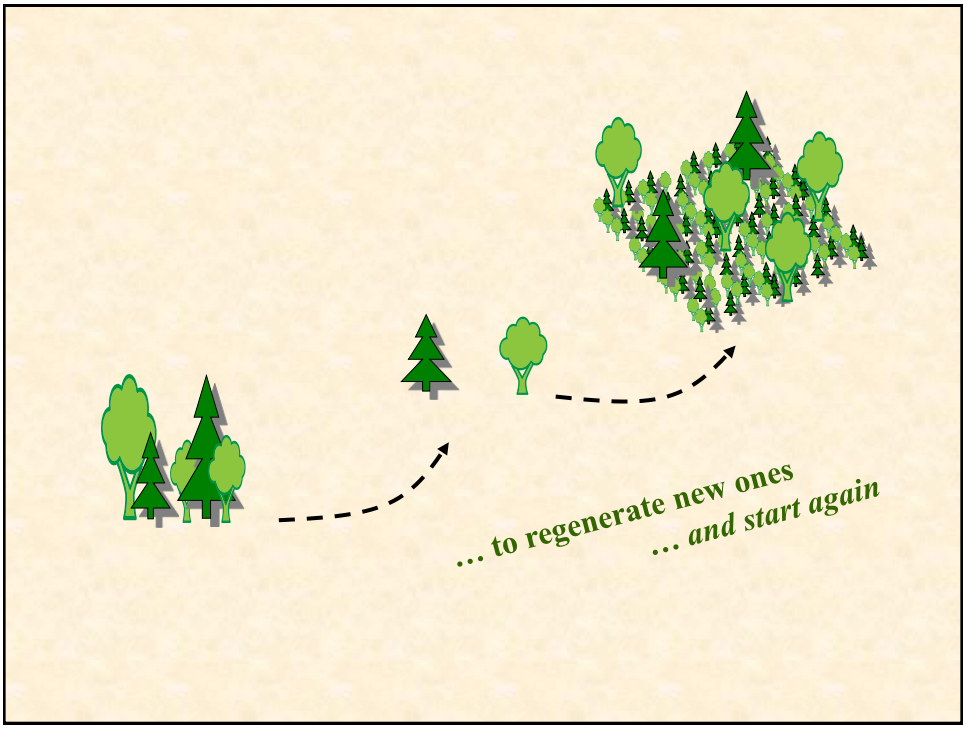
A young age class beneath older trees …

… we eventually remove the old trees
and thin the remaining age class



… to regenerate a new one
… *and start again*

… a regeneration cutting looks like this

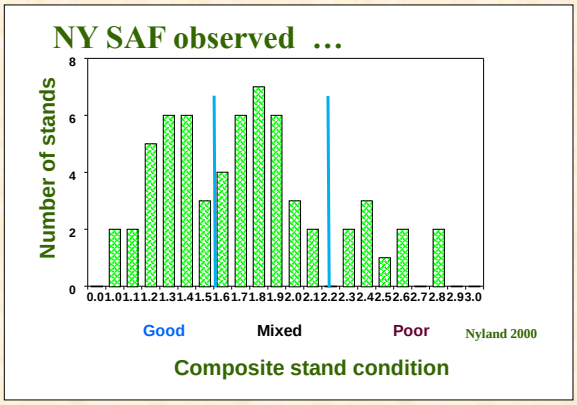


So …

Two distinct age classes present …
… great difference in age between the two
… each comes of age at a different time

But we found NO two-aged stands to study …

So let's return to the NY SAF harvesting evaluation …



… and examine residual conditions in already cut stands

We did NOT find only poor species …

… diameter-limit cutting in even-aged northern hardwoods removed most shade-intolerant trees

... like black cherry white ash

… but left sugar maple or a usable species

Species By Decreasing Degree Of Shade Tolerance

American beech	**Really very tolerant***
Sugar maple	**Very tolerant**
Red maple	**Tolerant**
Yellow birch	**Intermediate**
White ash	**Intolerant**
Black cherry	**Very intolerant**
Aspen	**Very intolerant**

* The most shade tolerant eastern hardwood

Burns and Honkala 1990

We did NOT find only poor species …

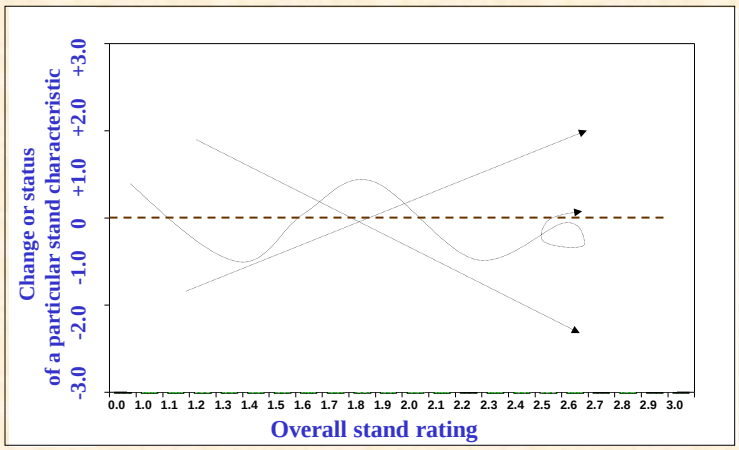
… diameter-limit cutting in **even-aged** northern hardwoods removed most shade-intolerant trees

… but left sugar maple

… in uneven-aged northern hardwood stands already dominated by sugar maple

… cutting left mostly sugar maple or a usable species

Using data from the NY SAF assessment, we can compare other conditions among stands …



… putting stands in order by overall rating, and examining the condition for each characteristic

Altogether, five other conditions will influence decisions …

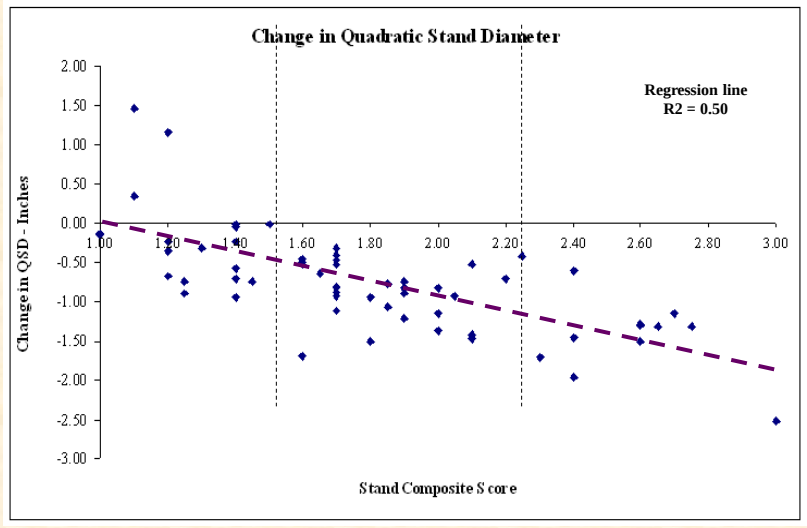
1. change of average diameter *(called QSD)*

… with QSD increasing or decreasing

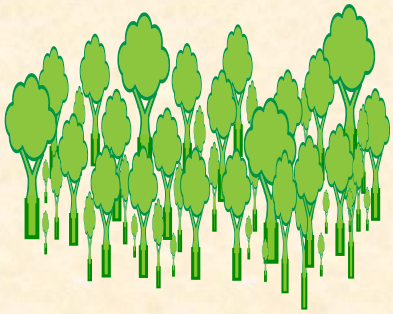
… most silvicultural treatments increase the average diameter

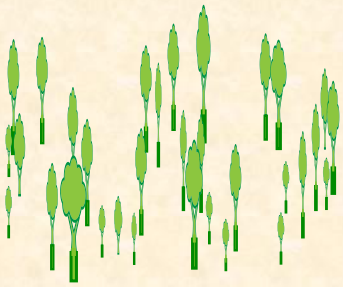
… or reduce it only slightly

Change in QSD (how many times smaller or larger) …



1.0 = ideal conditions **3.0 = awful conditions**





An even-aged stand …

… trees all the same age

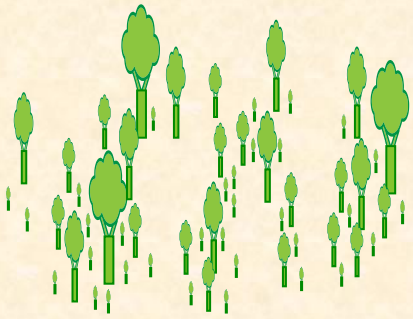
… removing the biggest trees of the age class

Mostly diameter-limit cutting …

… transforming this

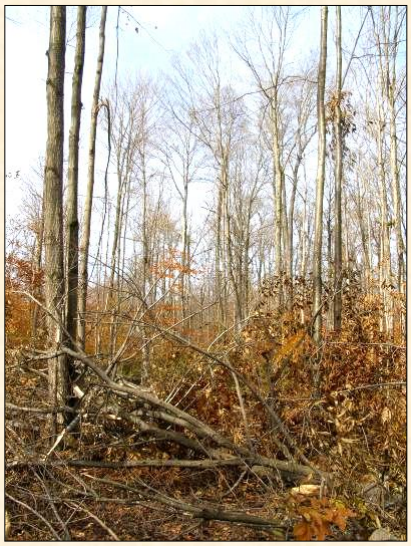
… to this

An **uneven-aged** stand …
… trees of several ages



… removing the **older age class**

… this example before



… and after a second diameter-limit cut

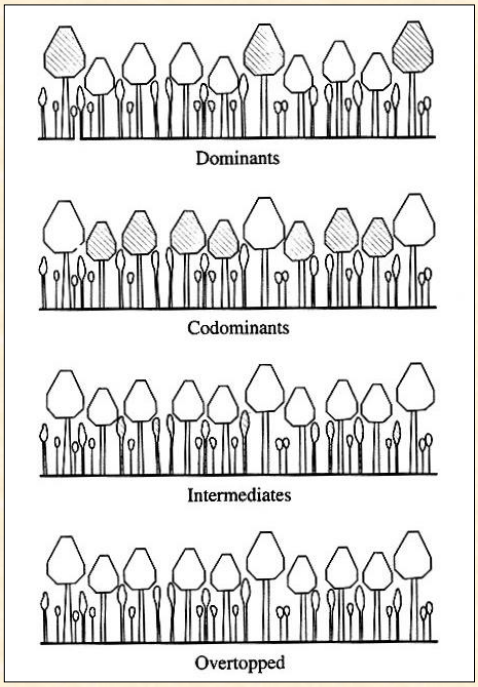
Altogether, five other changes will influence decisions …

2. change in potential for future growth and production

… and especially the difference between even- and uneven-aged stands

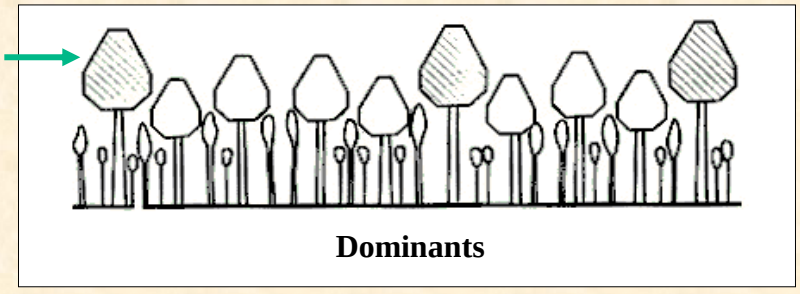
So start with even-aged stands …

… after diameter-limit cutting



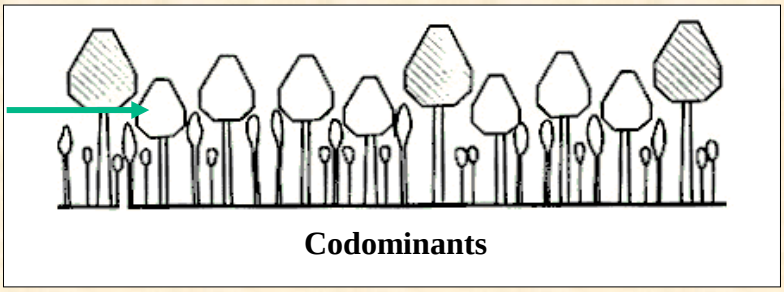
We assign trees to different crown classes ...

… with even-aged stands



Genetically best …

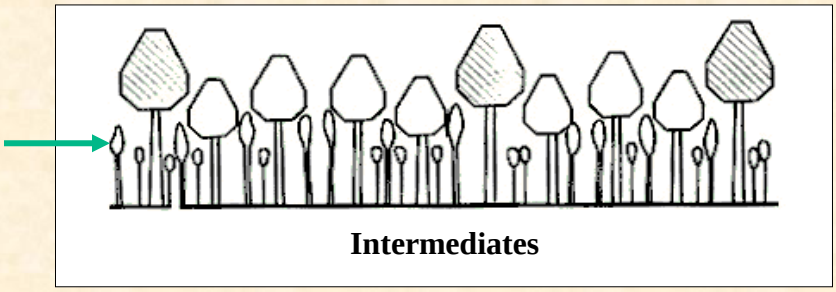
... the best
... the fastest growing
... the best promise



Codominants

Genetically good …

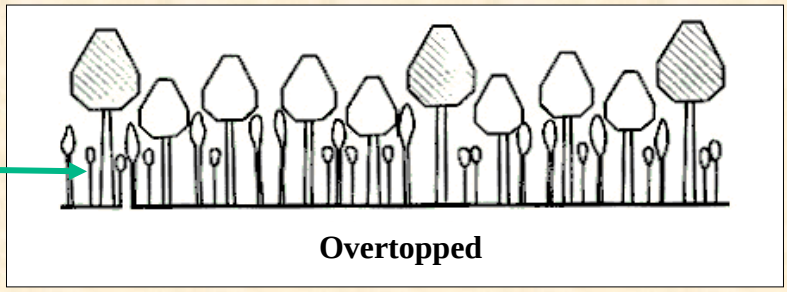
... good trees
... growing well
... good promise



Intermediates

Genetically poor …

... poor condition
... poorly growing
... poor promise



Overtopped

Genetically wretched …

... wretched trees
... weakly growing
... woeful promise

15-year post-thinning diameter growth of sugar maple trees in different initial crown positions

(B-level relative density)

Crown position	15-year total (in.)	Annual (in.)
Dominant	2.98	0.20
Codominant	1.95	0.13

Good growth after release …

Nyland et al. 1993

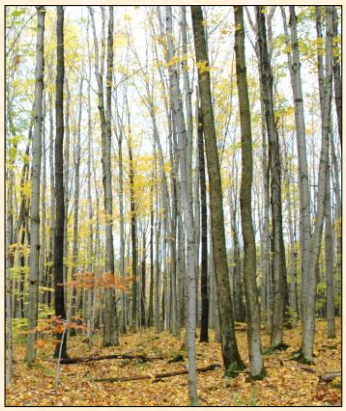
15-year post-thinning diameter growth of sugar maple trees in different initial crown positions
(B-level relative density)

Crown position	15-year total (in.)	Annual (in.)
Dominant	2.98	0.20
Codominant	1.95	0.13
Intermediate	**1.36**	**0.09**
Overtopped	**0.69**	**0.05**

D-limit cutting leaves these …

And note this …

… tree diameter related to crown position



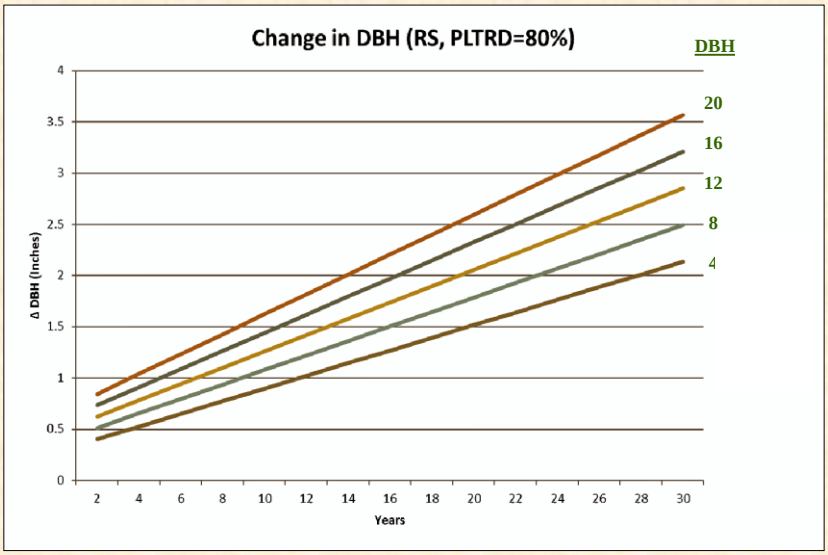
Dominants

> Codominants

> Intermediates

> Overtopped

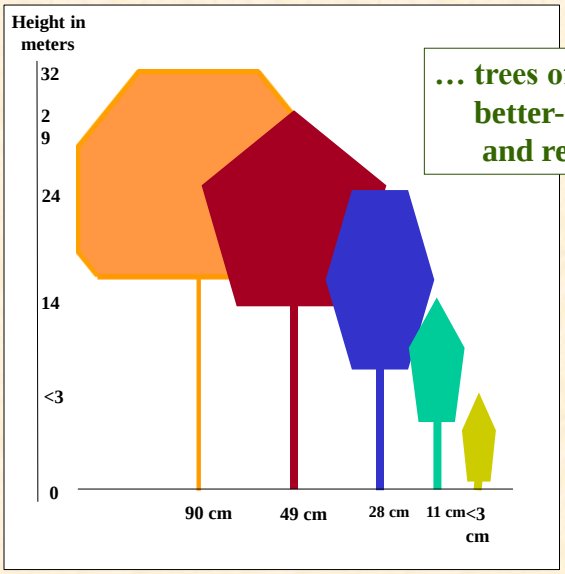
Big trees grow better …



Schmidt et al. 2013

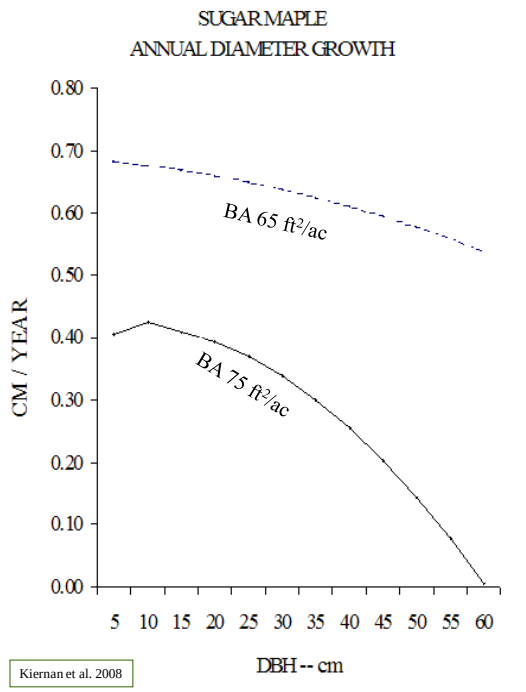
… once a runt, always a runt

Yet for uneven-aged stands …



… trees of all ages have better-developed crowns and reasonable vigor

… at least in managed stands



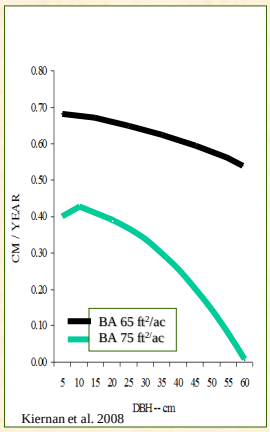
And trees of all ages (sizes) grow well …

… but slower at higher residual basal area

… sugar maple diameter growth in managed stands

With good growth *potential* among small trees …

Individual Tree Diameter Growth (Stands at 75 ft²/ac)

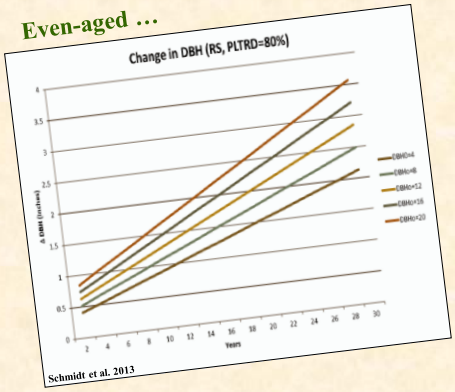


Kiernan et al. 2008

Dbh – in.	In./year	15-year total
4	0.13	**2.01**
8	0.14	**2.07**
12	0.14	**2.07**
16	0.13	**1.95**
20	0.11	**1.65**

… for Adirondack sugar maple

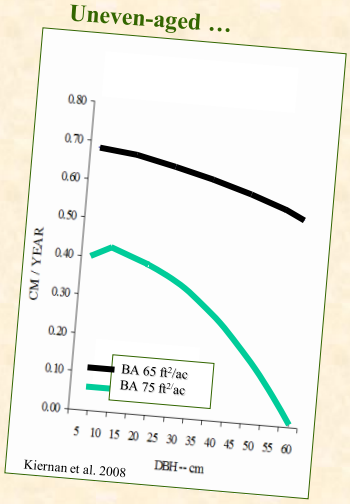
Even-aged …



Schmidt et al. 2013

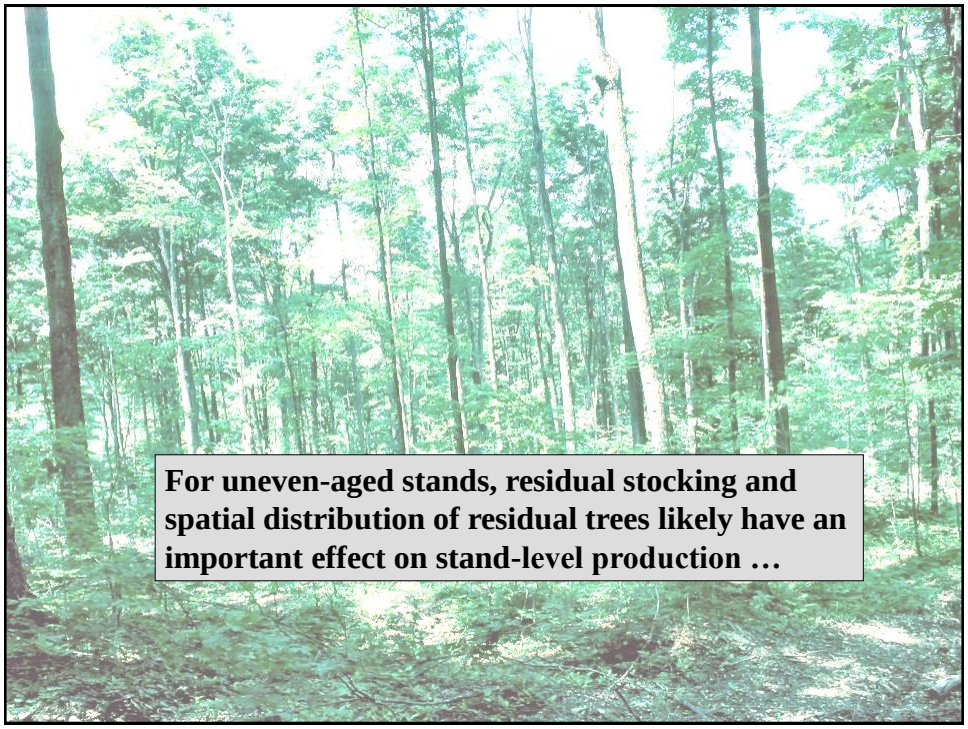
… what a critical difference

Uneven-aged …



Kiernan et al. 2008


And while not desirable for uneven-aged stands…
… diameter-limit cutting leaves small trees with at least reasonable growth potential


For uneven-aged stands, residual stocking and spatial distribution of residual trees likely have an important effect on stand-level production …

Altogether, five other changes will influence decisions …

3. change in residual tree quality

… asking if sufficient for future management

… with the numbers of good trees and their condition dictating the options

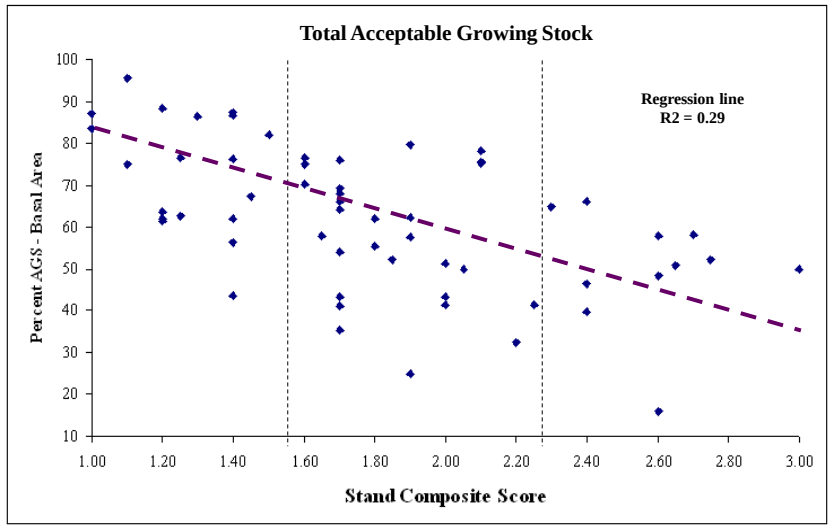
We only judged IF a tree would eventually have …

… at least one salable factory grade log

(Grade 3 or better, at least 8 feet long)

… not a high standard

AGS among all residual growing stock …

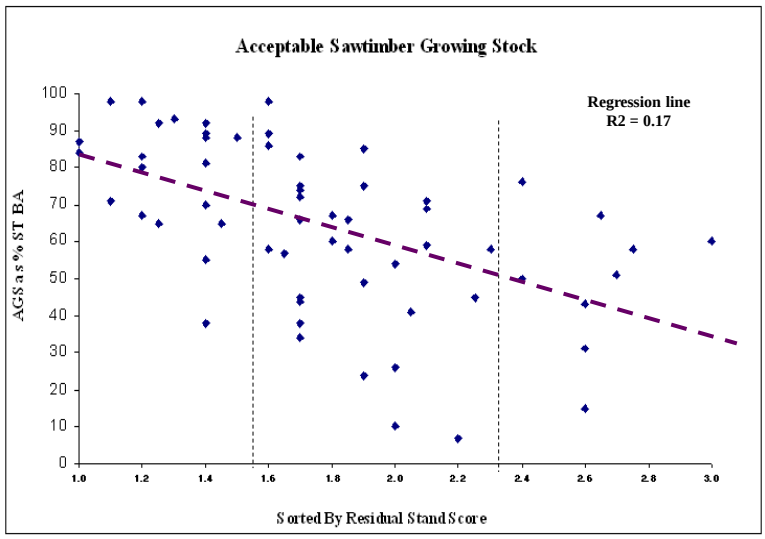


1.0 = ideal conditions

3.0 = awful conditions

AGS among residual sawtimber …

… based on lower bole quality



1.0 = ideal conditions

3.0 = awful conditions

With diameter-limit cutting … ***… the best removed*** *(even-aged)*

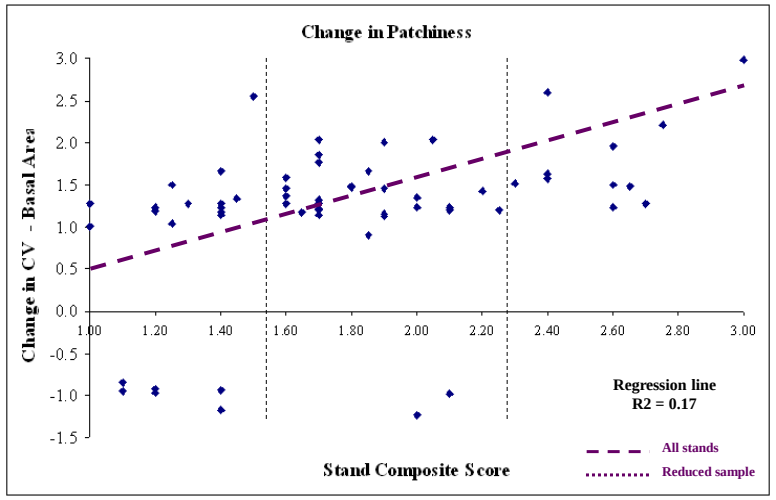
… the best removed
(uneven-aged)

Altogether, five other changes will influence decisions …

4. change in patchiness of residual stocking

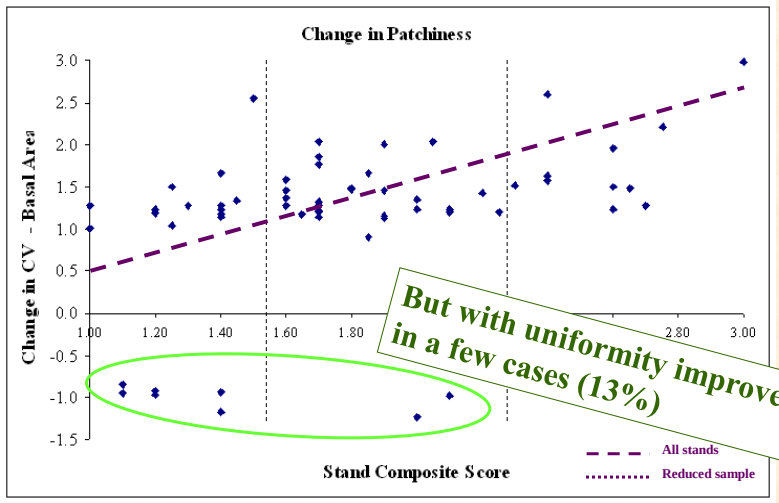
… and how that limits the potential for a single treatment throughout the stand

Change in patchiness (negative means less patchiness) …



1.0 = ideal conditions **3.0 = awful conditions**

Change in patchiness (negative means less patchiness) …



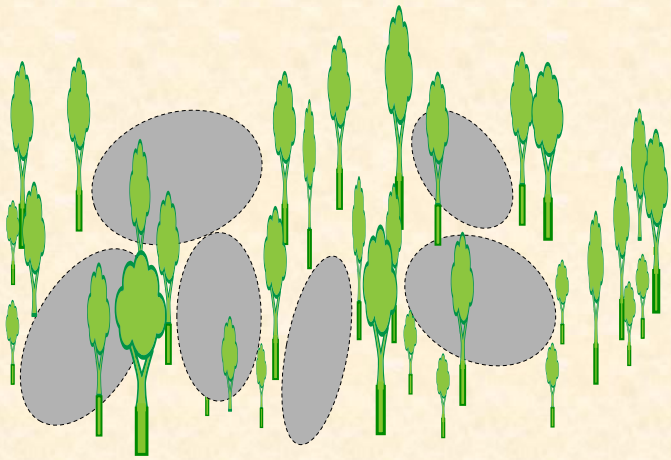
1.0 = ideal conditions

3.0 = awful conditions

An even-aged stand …

… growing together like this

Or after diameter-limit cutting …



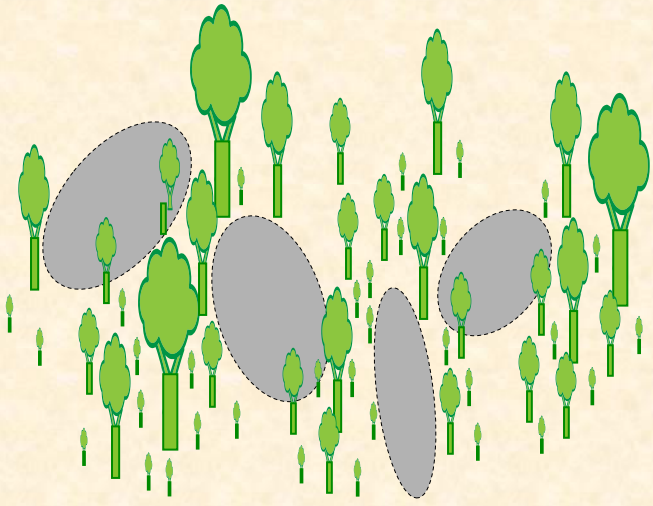
… disturbed even-aged (patchy)

… patchy (even-aged)

An **uneven-aged** stand …

… growing together like this

Or after diameter-limit cutting …



… disturbed **uneven-aged**

… patchy (uneven–aged)

Altogether, five other changes will influence decisions …

5. likelihood of interference

… to inhibit success with either a natural or artificial regeneration method

… usually if interfering plants cover 1/3 or more of the stand area

… not measured in the NY SAF assessment
… but something to check when looking for advance regeneration

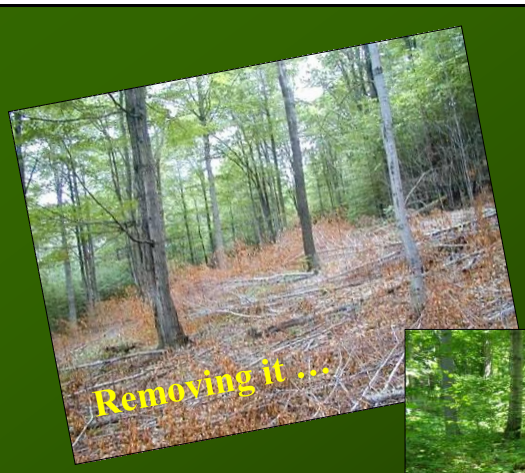
These interfering plants often a problem …

Before cutting

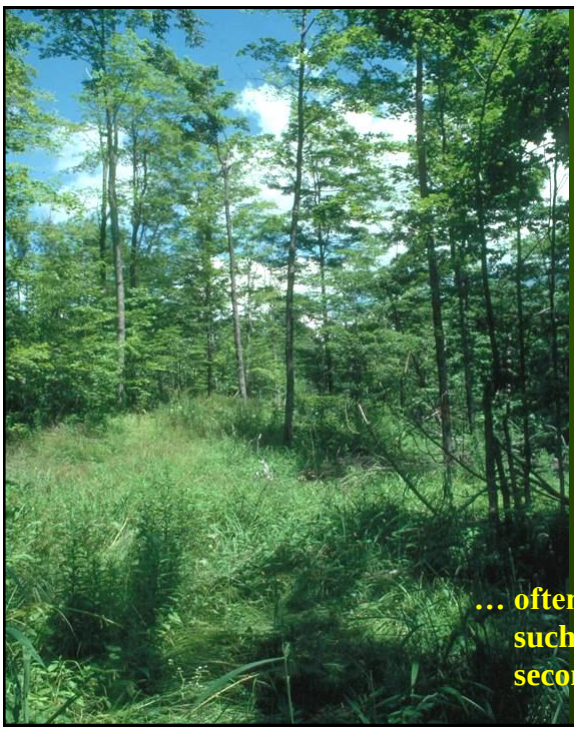
After cutting

… including past harvests

… often found on ≥ 1/3 of the area in aftermath stands



… helps promote desirable regeneration



Or ferns and grasses …

… often we must deal with such interference after a second diameter-limit cutting

So at least five factors will influence decisions when planning rehabilitation after many kinds of disturbances…

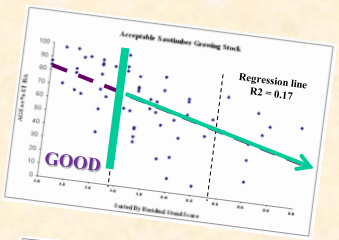
1. **change of average diameter**
2. **potential for future growth**
3. **change in residual tree quality**
4. **patchiness of residual stocking**
5. **likelihood of interference**

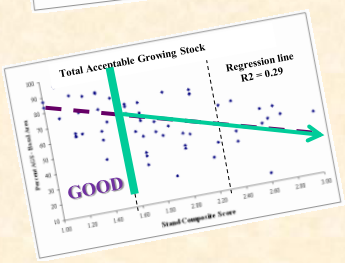
But note this …

GOOD stands …

… differ from MEDIOCRE

… and POOR stands

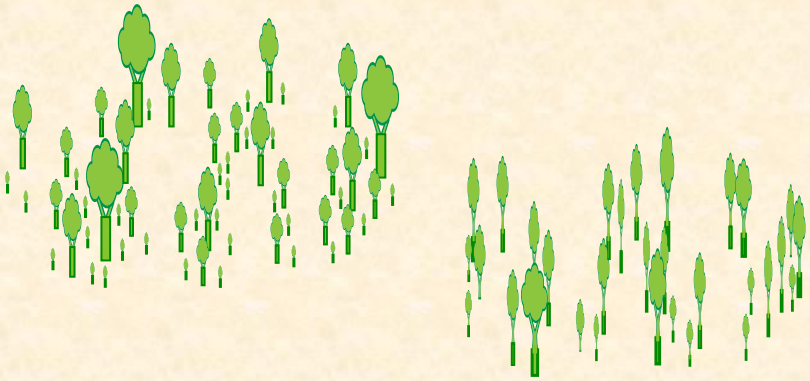




Rehabilitation applies to the Mediocre and Poor …

… regular silviculture works in Good stands

And **patchiness** …

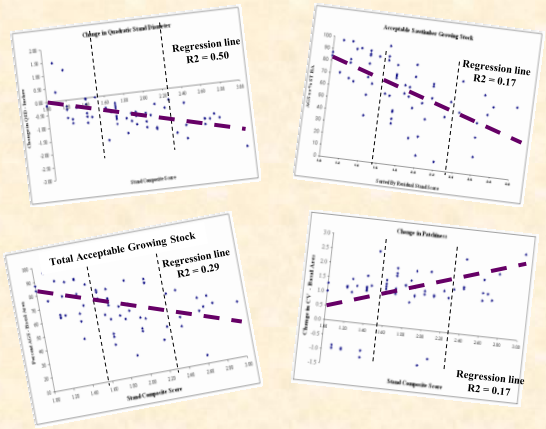


… importantly complicates prescription making

Patchiness results not only from irregular distribution of residual trees …

… but also irregular stocking of useable ones

Confounded by the great degree of variability in residual conditions from one cutover stand to the next ….



… and with important differences among stands having similar overall ratings

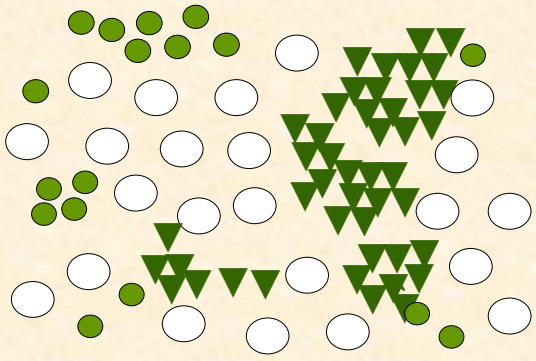
So while a single technique at low residual density …

… may suffice in some cases

For most cutover stands …

… patchiness and stand-to-stand variation complicate decisions about what will enhance the future

With conditions often requiring separate treatments for different parts of a stand …



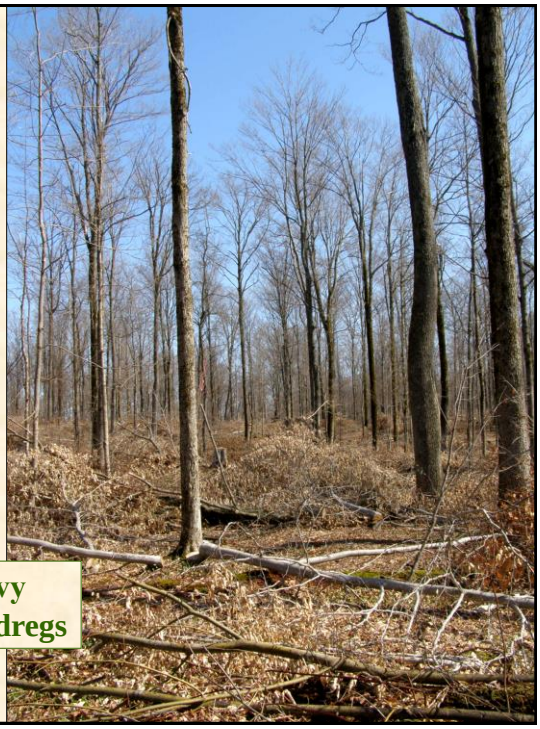
After Kenefic et al. 2013

And remember …

… cutover stands have only a few good trees

… but often some at wide spacing

… usually requiring heavy cutting to remove the dregs

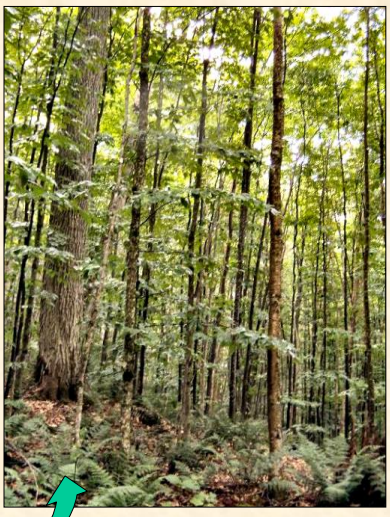


… perhaps partially cutting some areas

… establishing a new age class as well

… to initiate a 2-aged arrangement

Leading to this …



… and eventually this

… and clearing off all the poor residuals in other places

… using natural regeneration to replace the old

… a good option for stands with abundant and well distributed **advance regeneration** of desirable species

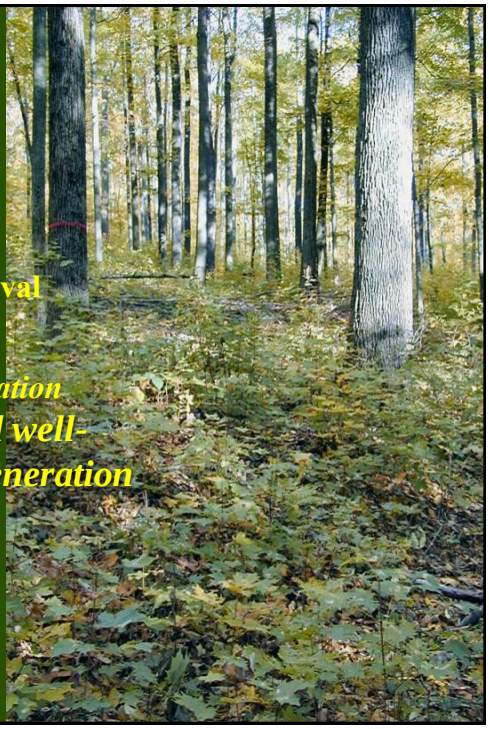
Just remember …

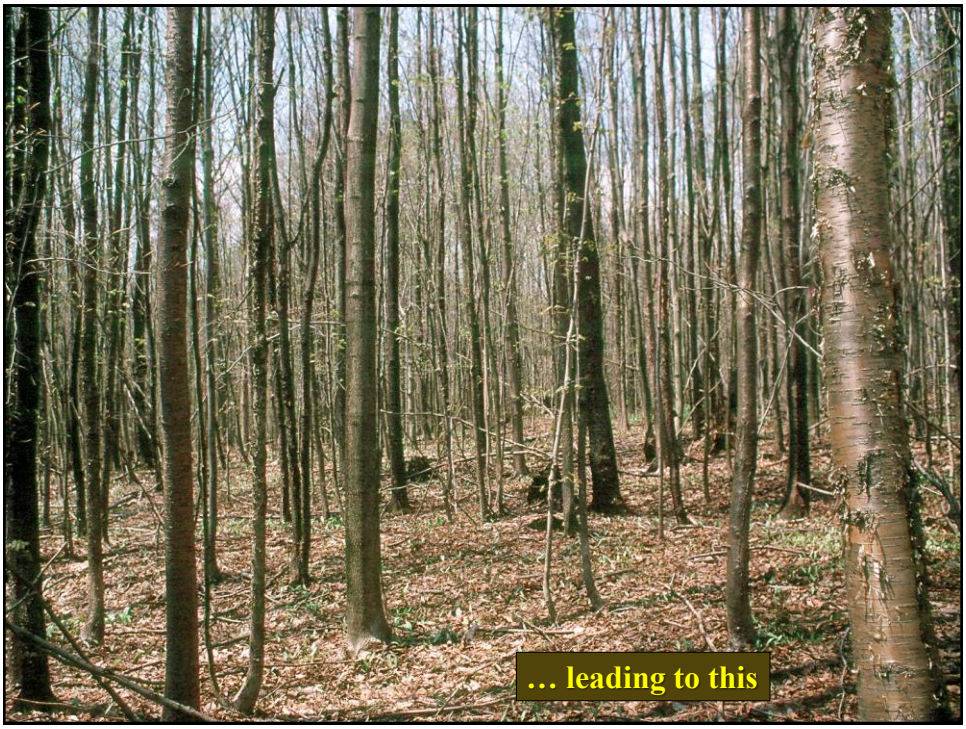
… in many forest types …

… complete overstory removal

… reliable for natural regeneration only when abundant and well-developed advance regeneration already in place

… particularly for types having a key species of high shade tolerance





And in some places …

… liberating a younger and well-developed understory from oppression by overstory UGS

… to promote its growth and development

Or thinning patches of acceptable residual trees …

… without needing to regenerate anything beneath them

Transforming this …

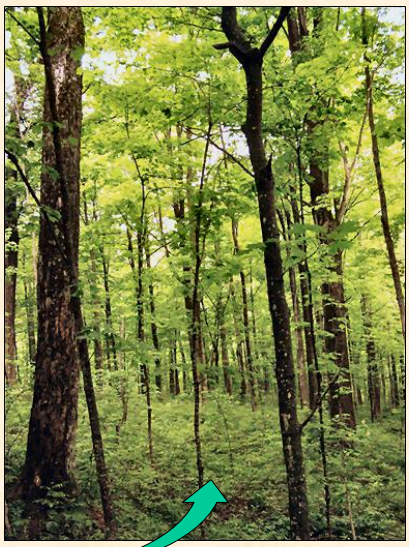
… to this

… likely to low residual stocking

Or cutting to low density in uneven-aged areas …

… moving long-term toward a balanced condition

Starting a new age class …



… and enhancing production

Or making a drastic transformation in badly depleted places of little hope …

… and lacking advance regeneration

… leading to stand conversion

Transforming this …

… to this

Integrating multiple options within a single stand …

e.g.,

1 - Low-density thinning in even-aged patches of AGS, no regeneration needed

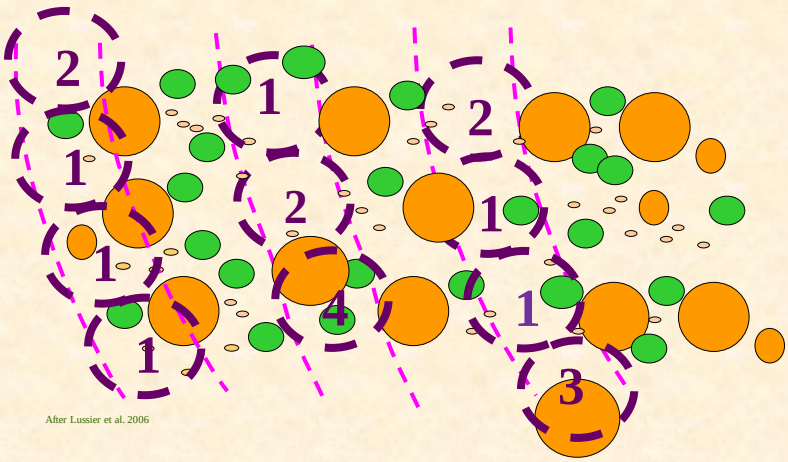
2 – Complete overstory removal in patches of UGS, releasing advance regeneration or young trees

3 - Shelterwood cutting in patches, to establish missing advance regeneration

4 – Selection cutting in uneven-aged areas, to establish regeneration and promote residual tree growth

After J.M. Lussier, et al., 2006

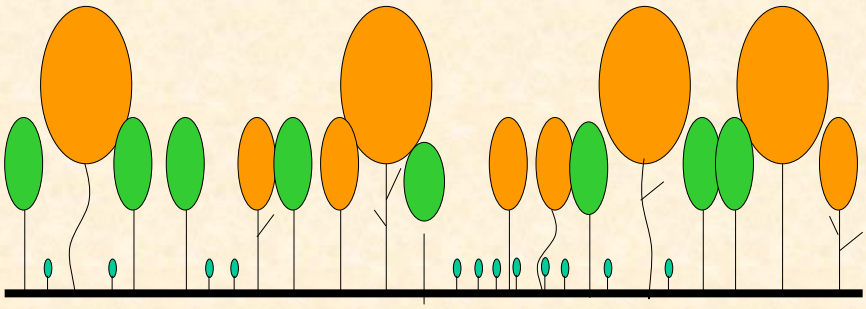
Requiring a combination of even-, uneven-, and two-aged silviculture in the same stand …



After Lussier et al. 2006

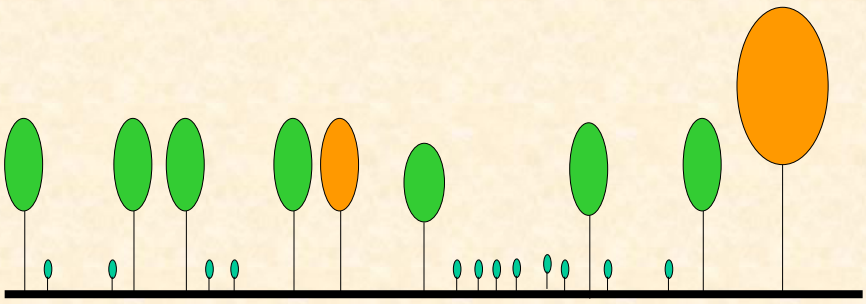
… leaving an irregular structure and mixed age classes

As with this stand …



… where past harvesting left an *any-aged* condition

… of mixed quality



Rehabilitated to a more promising condition …

… with an admixture of condition classes throughout

REQUIRING …

… well-planned silviculture based on a valid inventory

… done in new and creative ways

And in the process …

… reviving the vitality of forested ecosystems

… reestablishing appropriate biologic diversity

… reducing the spread of invasive plants

… reversing chaotic ecologic conditions

… and reclaiming the capacity for wood volume production

… regaining "control"

… based on a *multi-treatment* strategy for many cutover stands

So the *real* need …

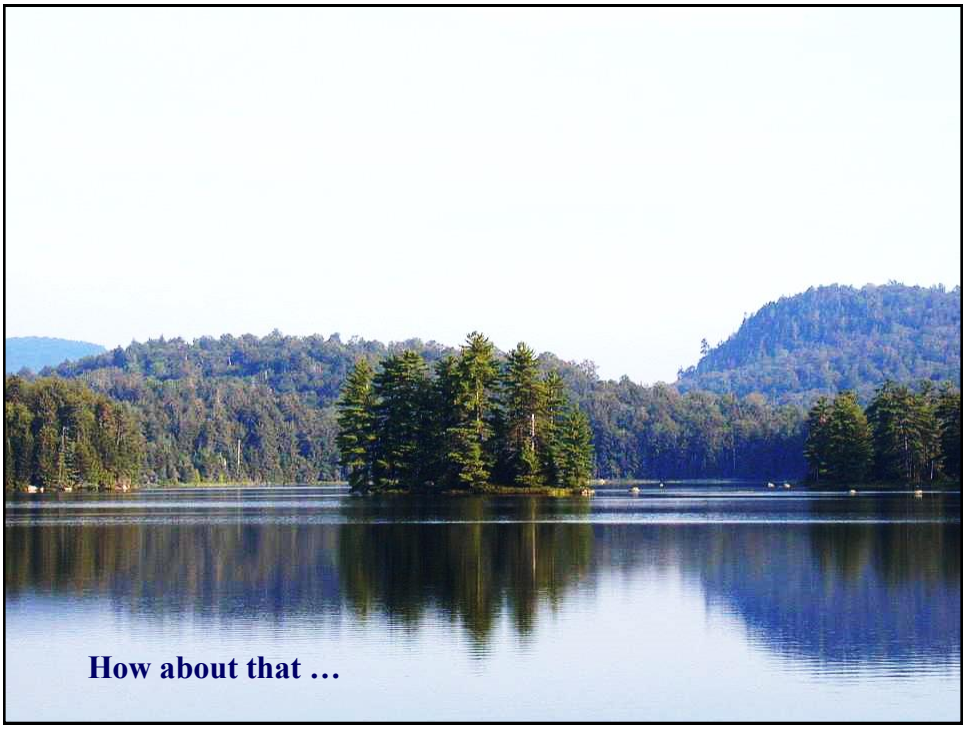
… to overcome the bothersome past

… consider a *new* multi-treatment approach

… rehabilitating chaos in a controlled and deliberated manner

… multi-treatment silviculture

… from the bag of many tricks



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