

# **An Introduction to SILVICULTURE**

October 13, 2018

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# Silviculture Defined

- The science (and art!) of growing trees/forests
- The application of ecological principles in controlling forest establishment, composition, health and growth
- To meet the needs and values of landowners and society

# Traditional Silviculture

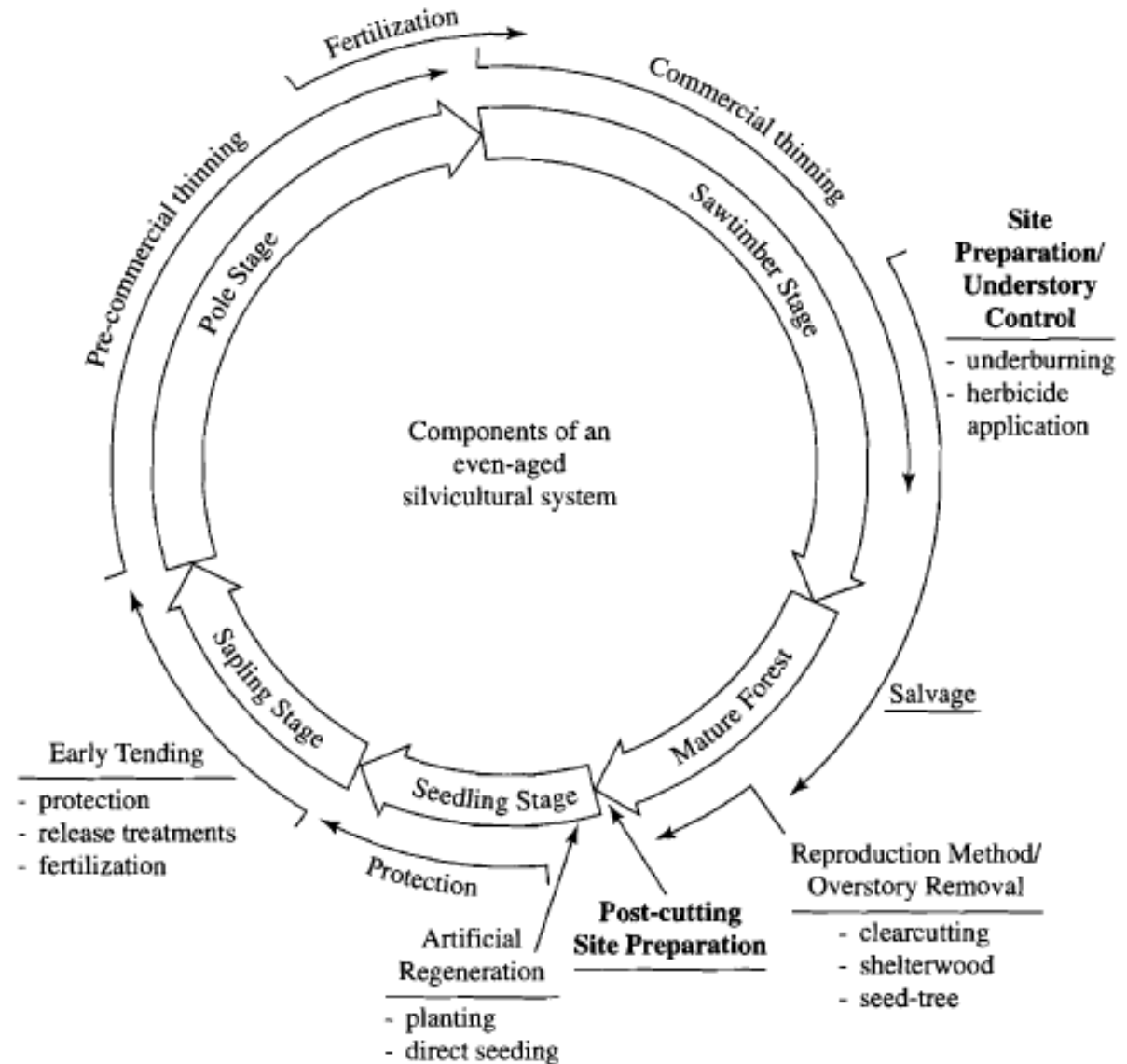
- Historically, a strong emphasis on timber production
  - Dominant focus on trees- what is good for the trees is good for the forest
  - Forest is messy and needs to be ‘tamed’ or ‘educated’
  - Pathology of Command and Control
- Resulted in unforeseen and undesirable consequences
- Difficulty responding to changing ecological knowledge, varied management objectives, and/or societal views of forests
- BUT – throughout history, silviculture was sometimes employed to promote wildlife habitats (for hunting), provide clean water, and even create aesthetic settings

- 1. Silvicultural Systems and natural disturbance**
- 2. Intermediate treatments**
- 3. Regeneration treatments**
- 4. Beyond traditional silviculture – managing for ecosystem function and complexity**



# Silviculture Systems vs. Treatments

- A silvicultural treatment is a single activity
- A silvicultural system is a series of treatments designed around long-term objectives
- If a **treatment** is not part of a **system** then it's not really silviculture



# Forest Disturbance

- Disturbance: Process that disrupts ecosystem composition, structure, and/or functioning
- Disturbance regime: The general pattern of disturbances in a forest type or region – including: return interval, severity, type

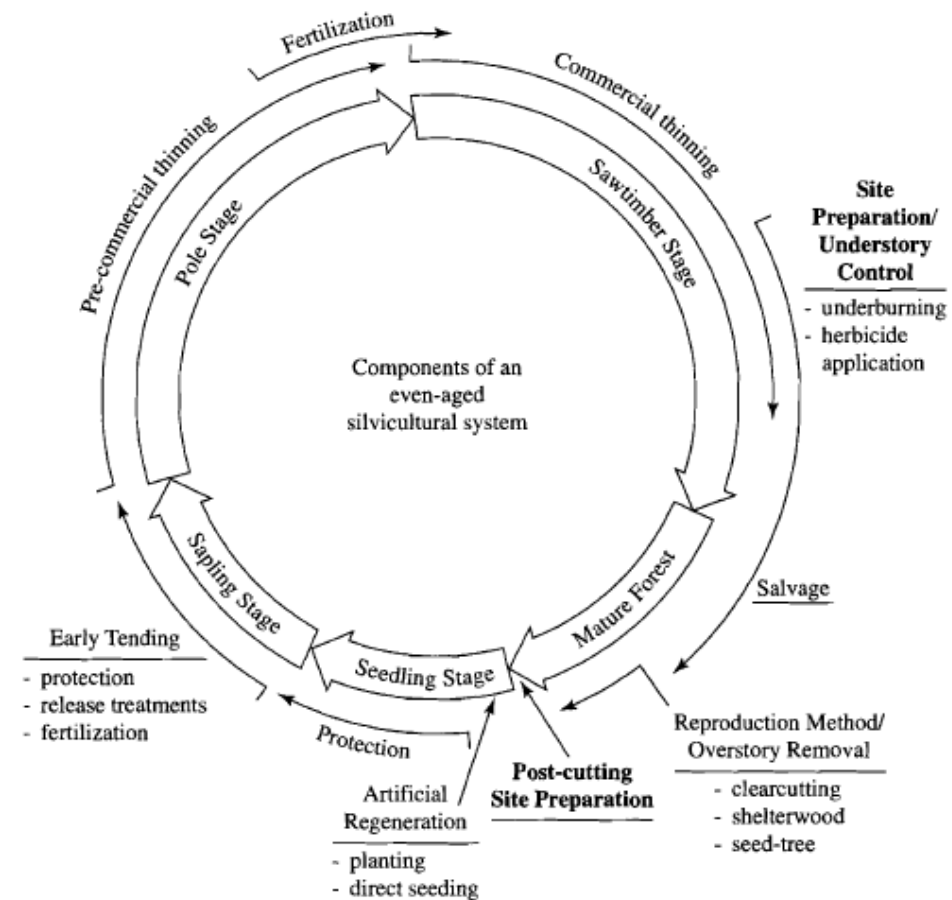


# Natural Disturbance as a Basis for Silviculture

- Silvicultural systems and treatments can be related to natural disturbance types – severity, scale, effect, frequency
- Not always designed based on specific disturbances or disturbance regimes – but increasingly the case
- Designed to promote specific species or communities – so often similar to (or based on) disturbances/regimes that promote those species

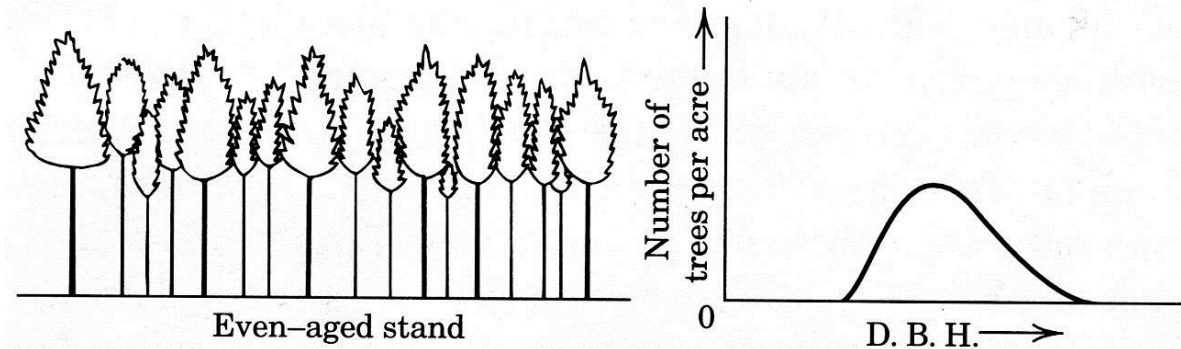
# Silvicultural Treatments

- Major distinction is between regeneration and intermediate treatments
  - **Regeneration treatments:** Establishing new trees (or releasing seedlings/saplings into the canopy)
- vs.
- **Intermediate treatments:** influencing density/structure/composition to achieve other goals
    - Eg. Thinning to increase growth of remnant trees

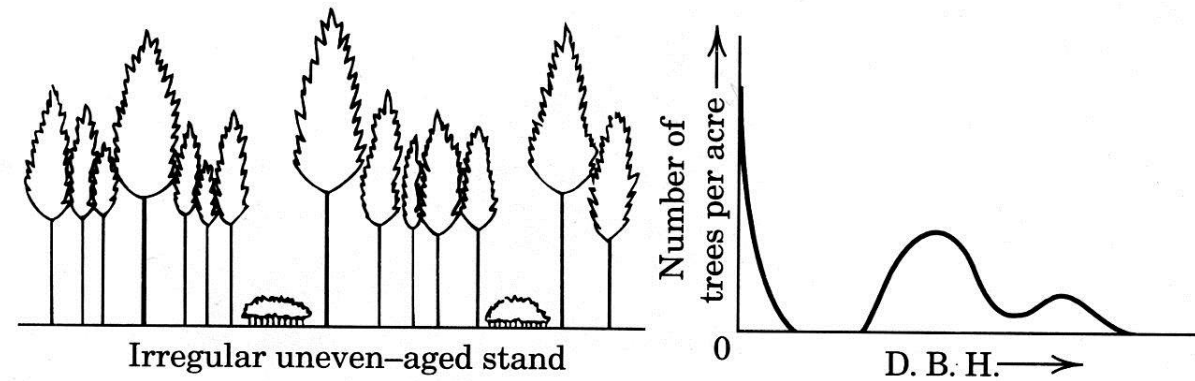


# Silvicultural Systems

- Major distinction is between **even-aged** and **uneven-aged** systems



vs.





# Silvicultural Systems

- Even-aged systems:
  - Clear cutting
  - Seed tree
  - Shelterwood





# Silvicultural Systems

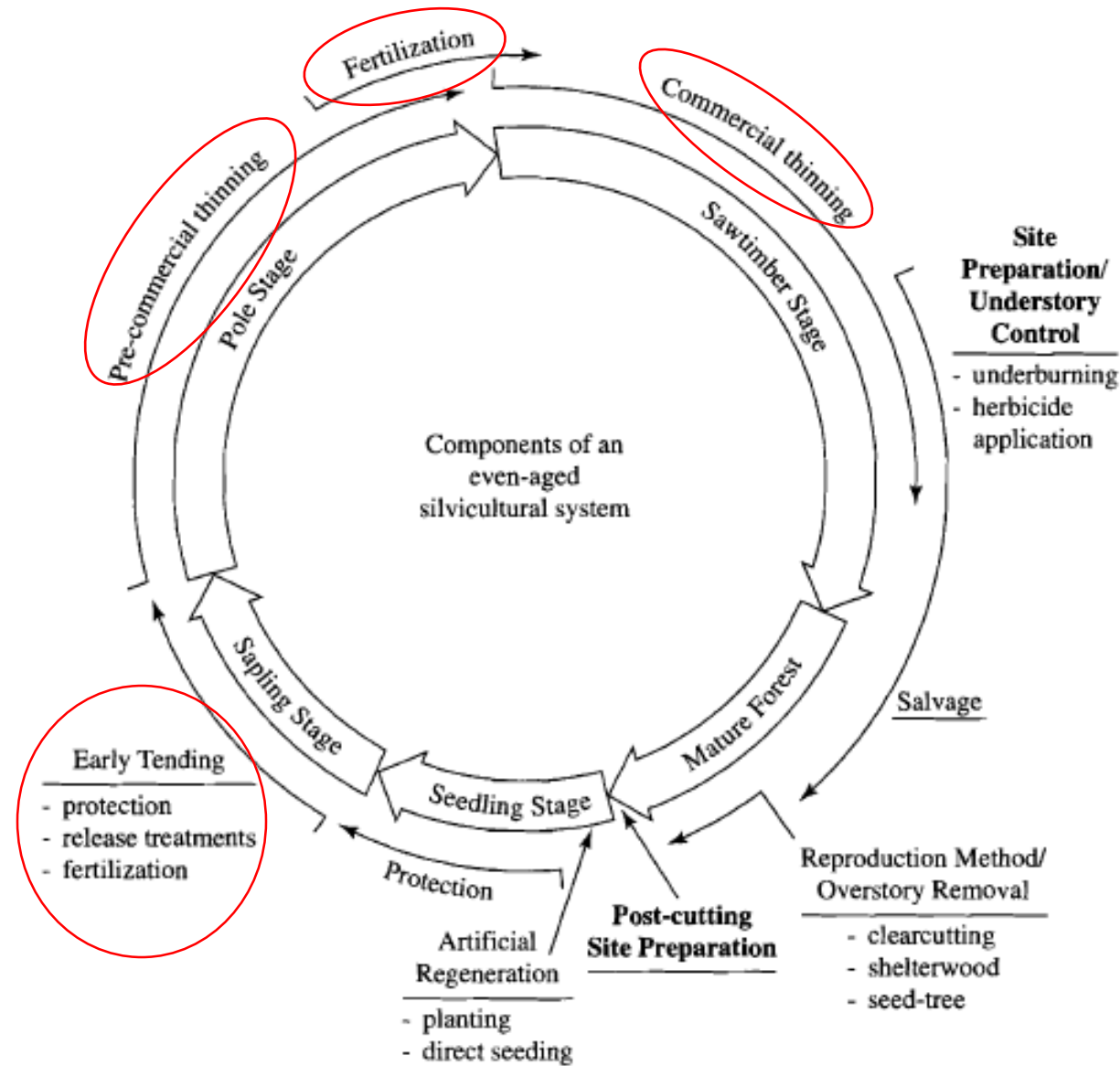
- Uneven-aged systems:
  - Single-tree selection
  - Group selection



# Silvicultural Treatments

- Intermediate Treatments – often a component of each of these systems
  - Commercial thinning
    - Above
    - Below
    - Crop tree release
  - Pre-commercial thinning
  - Pruning

# How intermediate treatments fit into a silvicultural system



# What is Thinning?

- Defined by Nyland as:

“A treatment to increase the diameter increment of residual trees, improve stand quality and health, and increase stand level production by cutting excess and potential mortality trees **without permanently breaking the crown canopy**”

## When we thin a stand...

- We are reallocating growing space to the residual trees
- Which residual trees you choose depends in large part on your objectives

## Thinnings:

Intermediate treatments in commercial-sized stands to redistribute the growing potential of a site to desirable growing stock.

- Salvage anticipated losses from competition mortality
- Increase diameter growth
- Yield income/ control investment
- Improve quality
- Alter species composition
- Reduce risk of damage

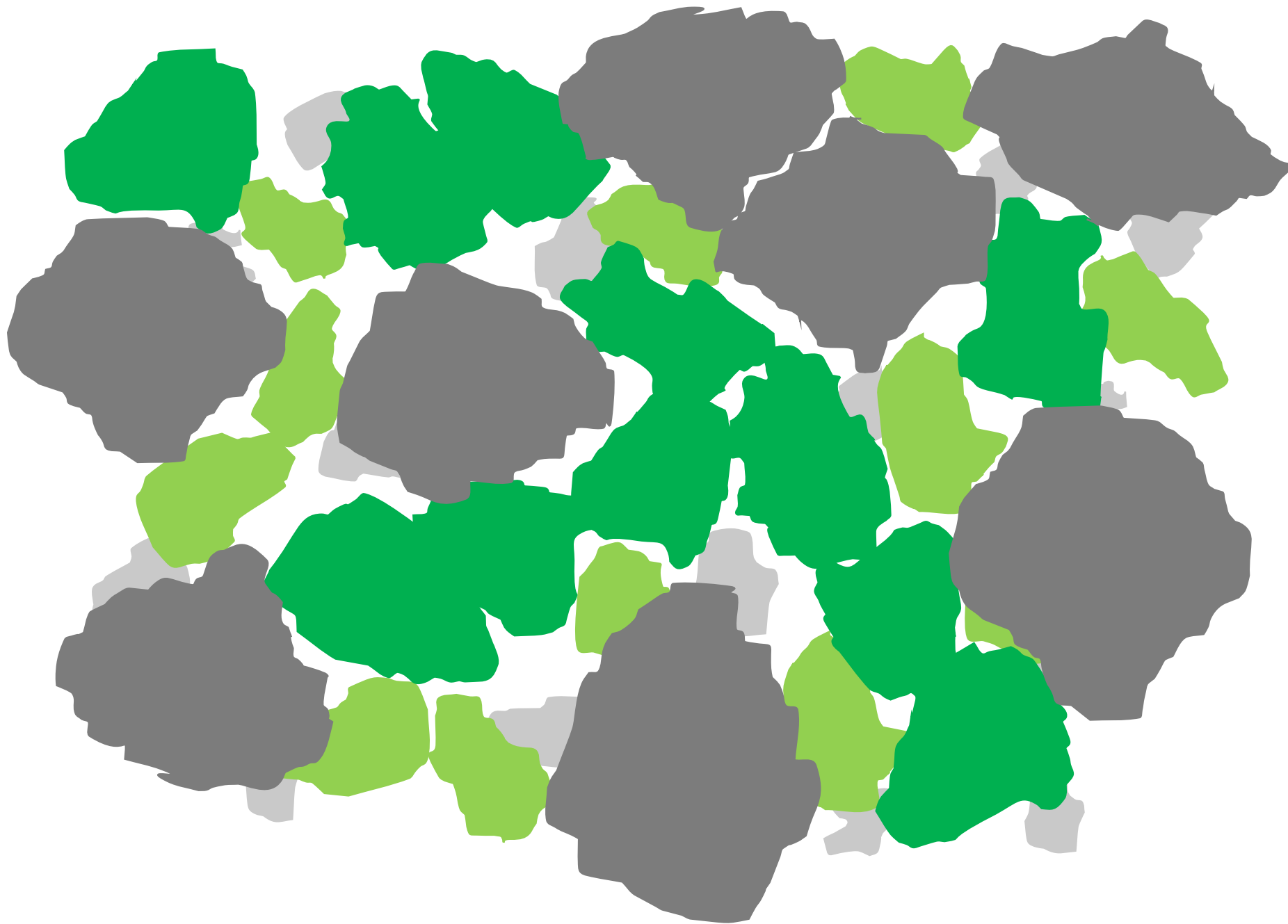
## Thinning Methods:

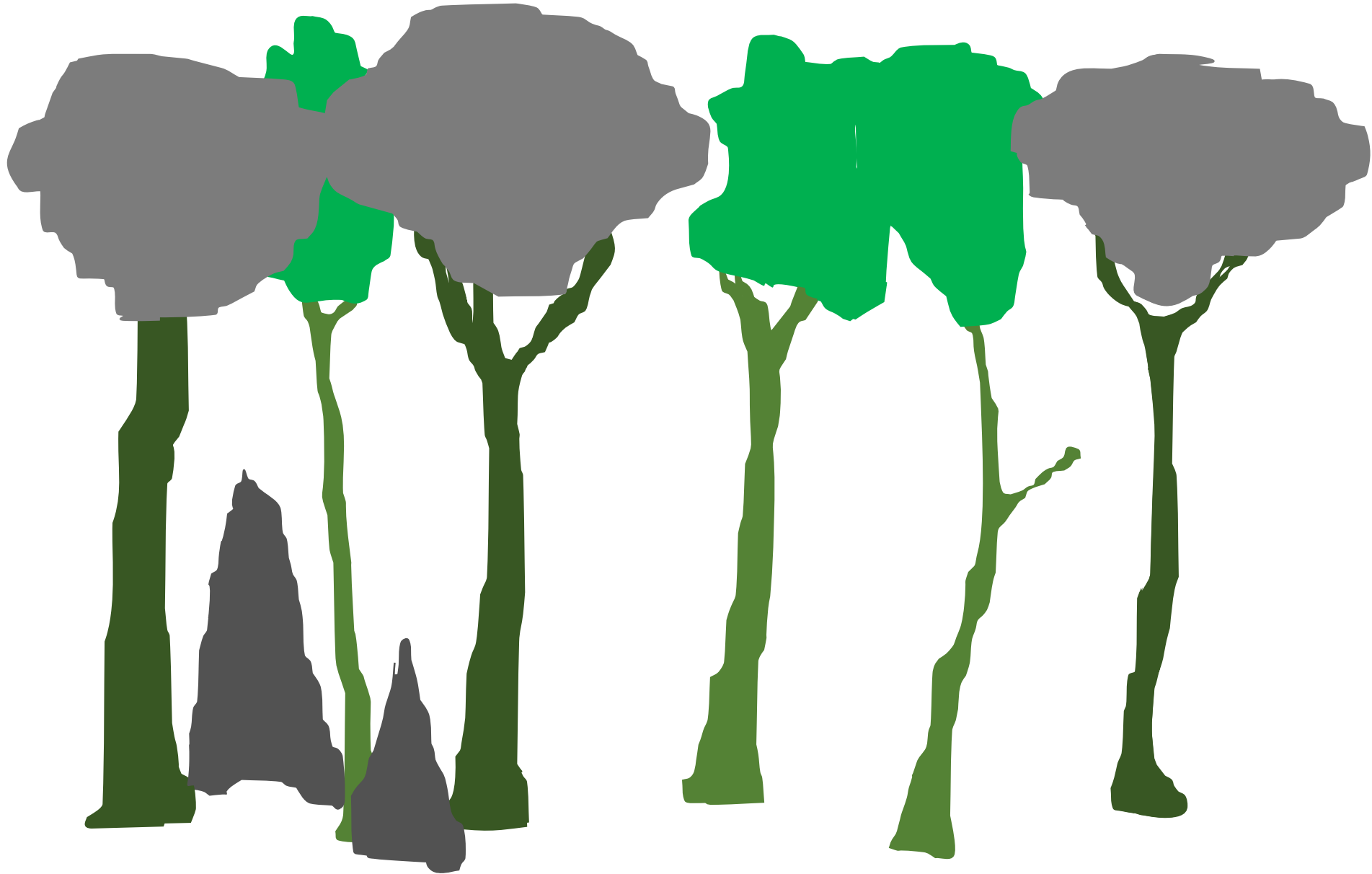
- Low thinning
- Crown thinning
- Selection thinning
- Mechanical or geometric
- Free thinning



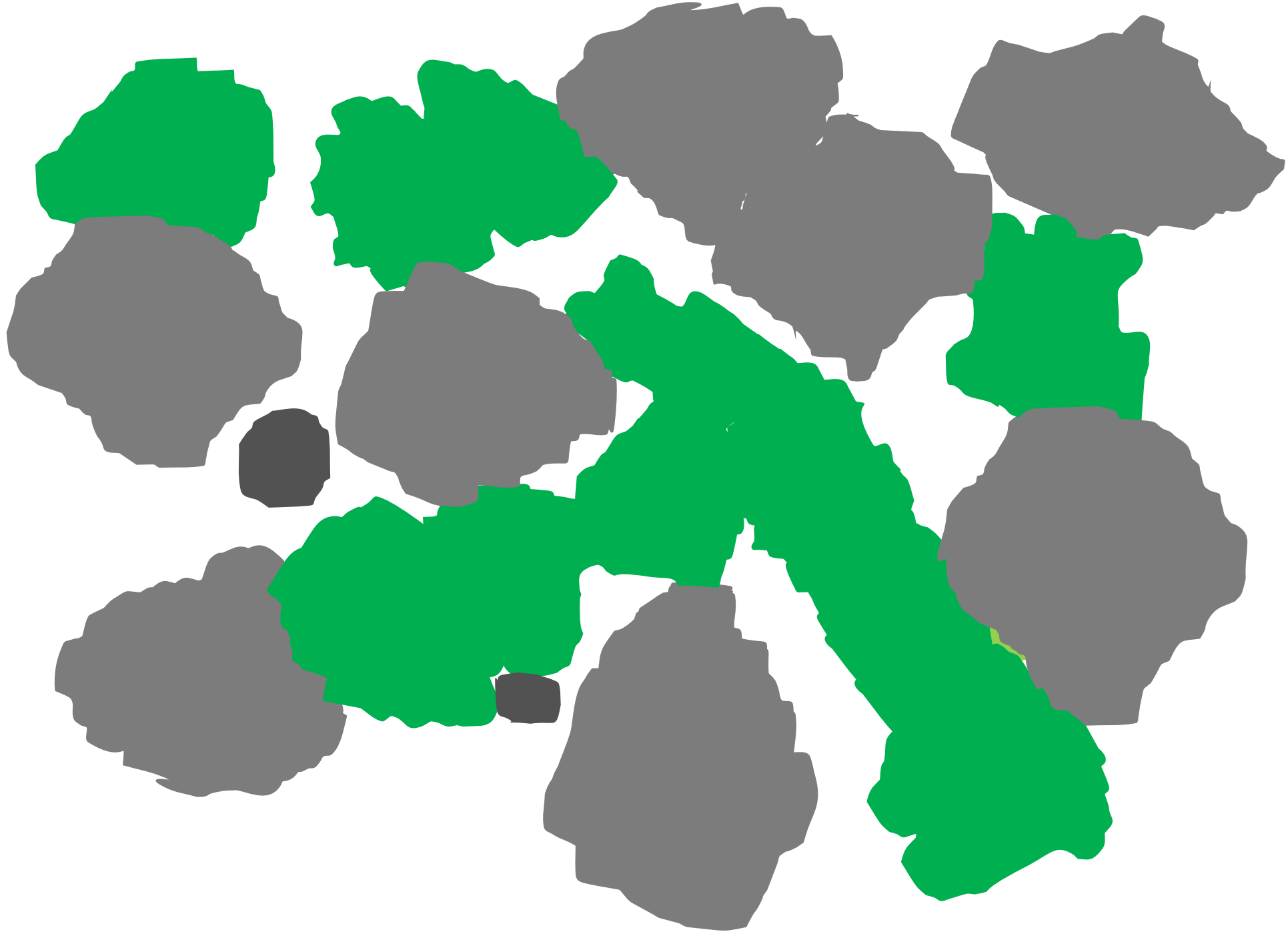
**Low thinning: remove intermediate and overtopped growing stock**







**Low thinning can be applied more than once and at varying degrees of intensity**



# Forest Products Scenario: RSD 17

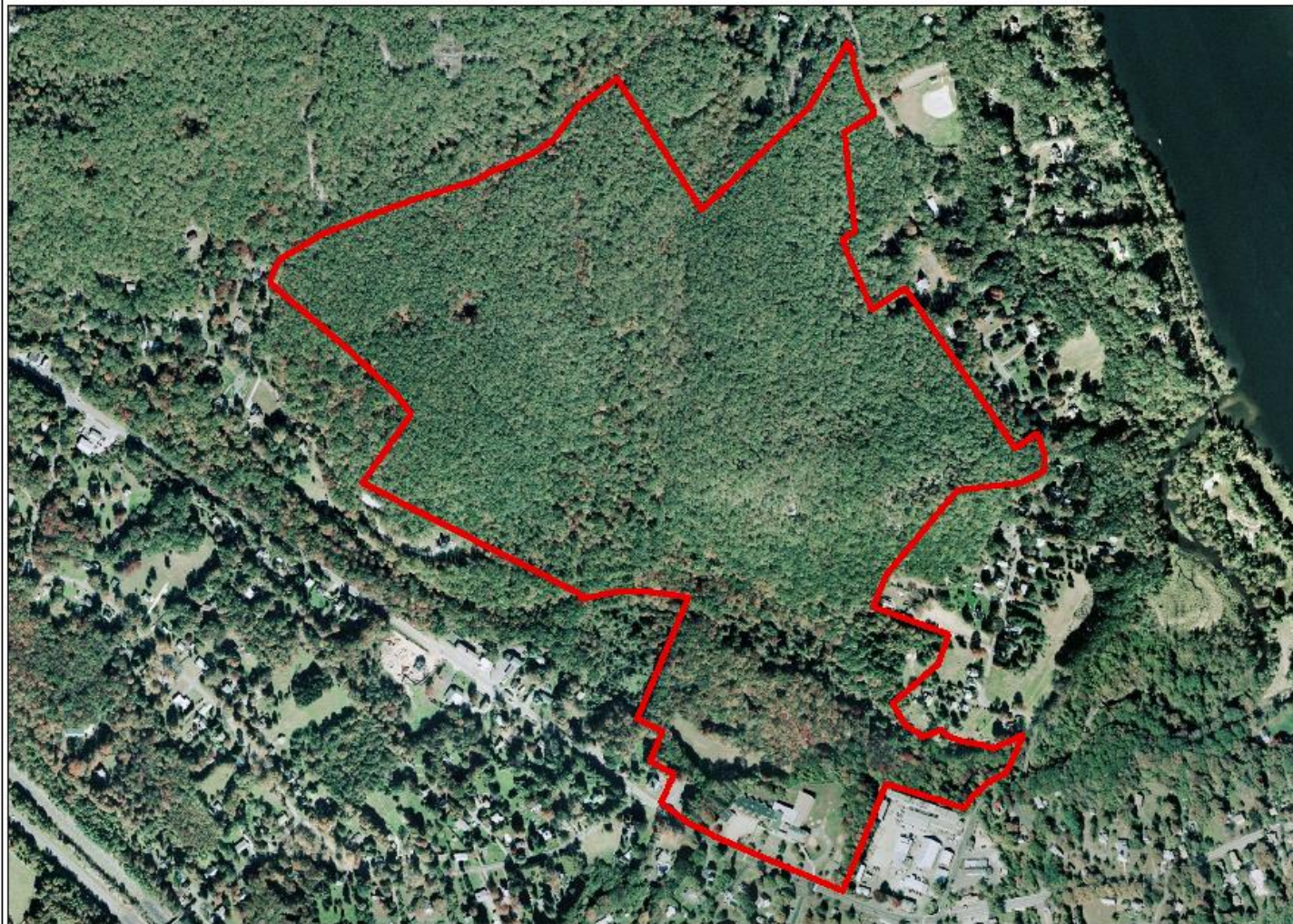


**Goal expressed:**

***Periodic harvests for continuous supply of oak lumber for HKHS technical arts program (~500 bf/yr).***



# Aerial - Summer: RSD17



0 500 1,000 2,000  
Feet



Map Layers:  
Aerial - Microsoft Bing Maps

Property Acres: 157.9  
Regional School District 17

Boundary information is approximate.  
For general reference only.

Printed: 1/7/2011



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Sources: ESRI, NRCS, CT DEP, UConn Extension  
Projection: CT State Plane (Feet) NAD83  
Project Design: Kyle Drennen, Joel Stocker,  
Thomas Worthley



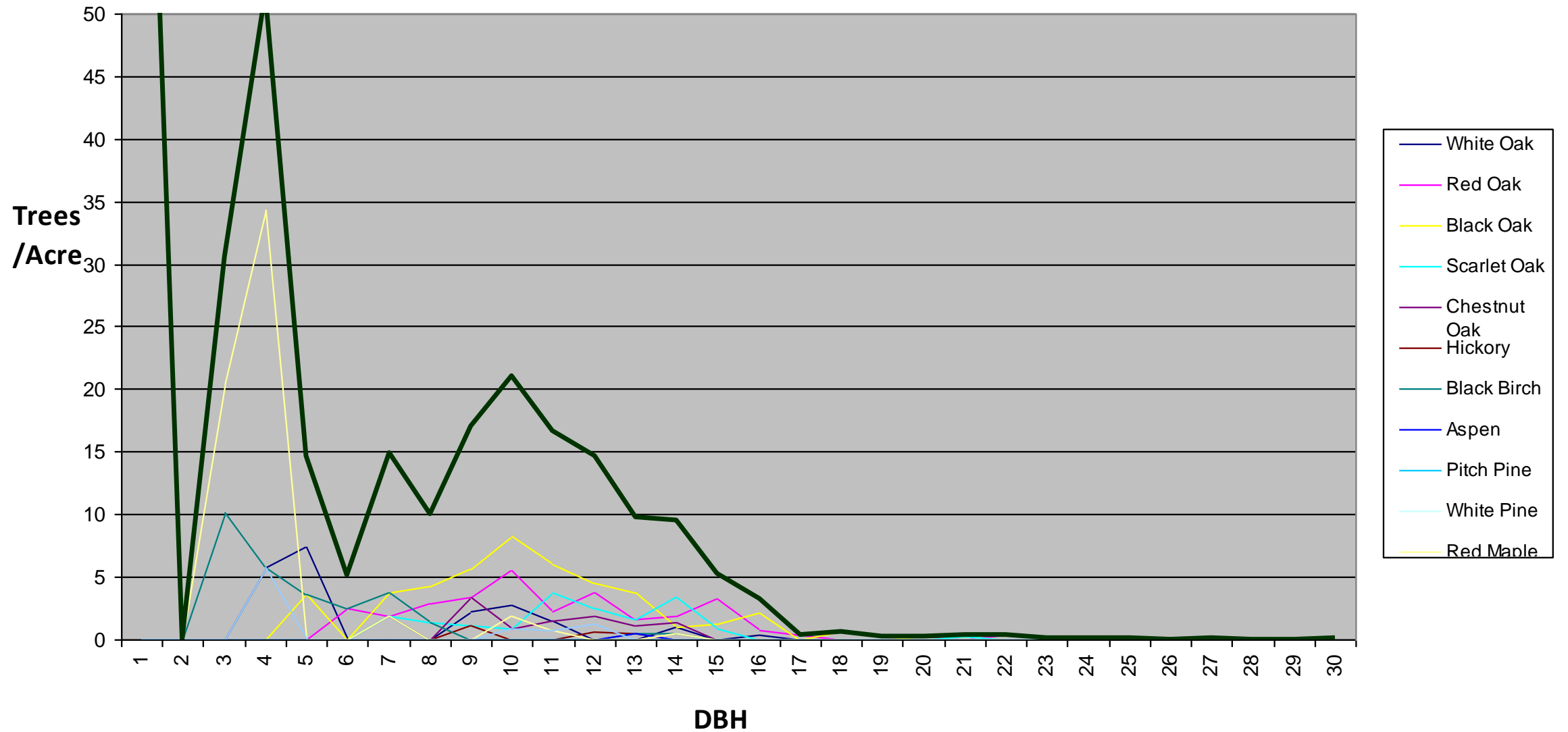




Stand Table (number of trees/acre by diameter and species)

Species											
DBH	White Oak	Red Oak	Black Oak	Scarlet Oak	Red Maple	Sugar Maple	Black Birch	Beech	Hemlock	White Pine	TOTAL
1						367					367
2					46	0					46
3					20	0	20	20			61
4					23	11	23	11	6		75
5							7				7
6						5			5		10
7			7				4				11
8	11		6	3	3		3				26
9	7		14					2			23
10	2	11	9	4		2				2	29
11	2	2	6	6	2						17
12		1	1	1						1	5
13	1	1	4	1							8
14		2	5	2							9
15		2	4	2							7
16		2	3	1							6
17			2								2
18		1	1	1							2
19		1	1								1
20											0
21			1								1
22											1
23											0
24			.5								0
25											0
26											0
27			.3								0
28											0
29											0
30											0
TOTAL:	23	22	64	20	94	385	57	34	17	8	714

## Number of Trees per Acre RSD 17 Oak Stand

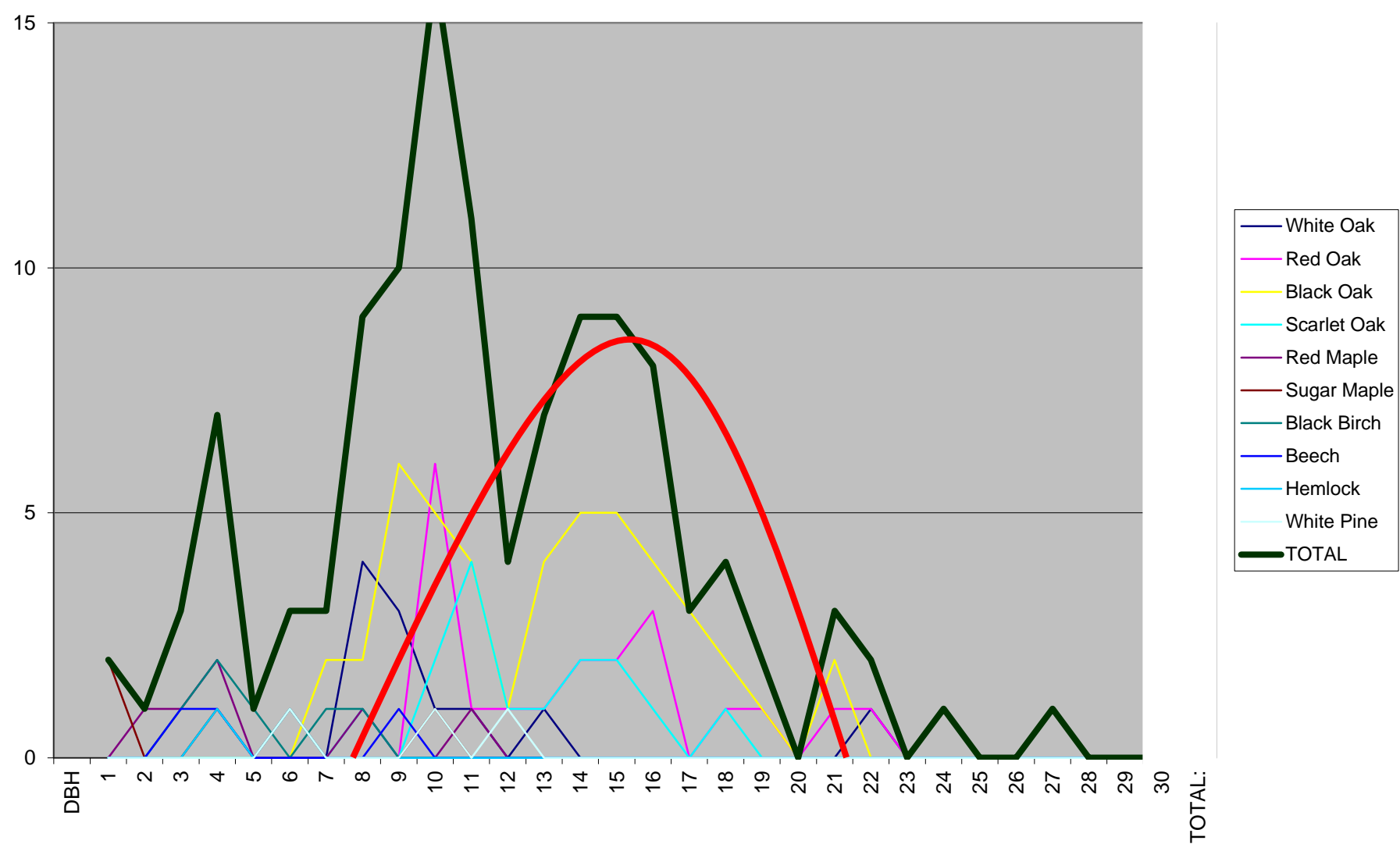


Basal Area Table (basal area/acre by diameter and species)

Species											
DBH	White Oak	Red Oak	Black Oak	Scarlet Oak	Red Maple	Sugar Maple	Black Birch	Beech	Hemlock	White Pine	TOTAL
1						2					2
2					1						1
3					1		1	1			3
4					2	1	2	1	1		7
5							1				1
6						1			1		2
7			2				1				3
8	4		2	1	1		1				9
9	3		6					1			10
10	1	6	5	2		1				1	16
11	1	1	4	4	1						11
12		1	1	1						1	4
13	1	1	4	1							7
14		2	5	2							9
15		2	5	2							9
16		3	4	1							8
17			3								3
18		1	2	1							4
19		1	1								2
20											0
21		1	2								3
22	1	1									2
23											0
24			1								1
25											0
26											0
27			1								1
28											0
29											0
30											0
TOTAL:	11	20	48	15	6	5	6	3	2	3	118

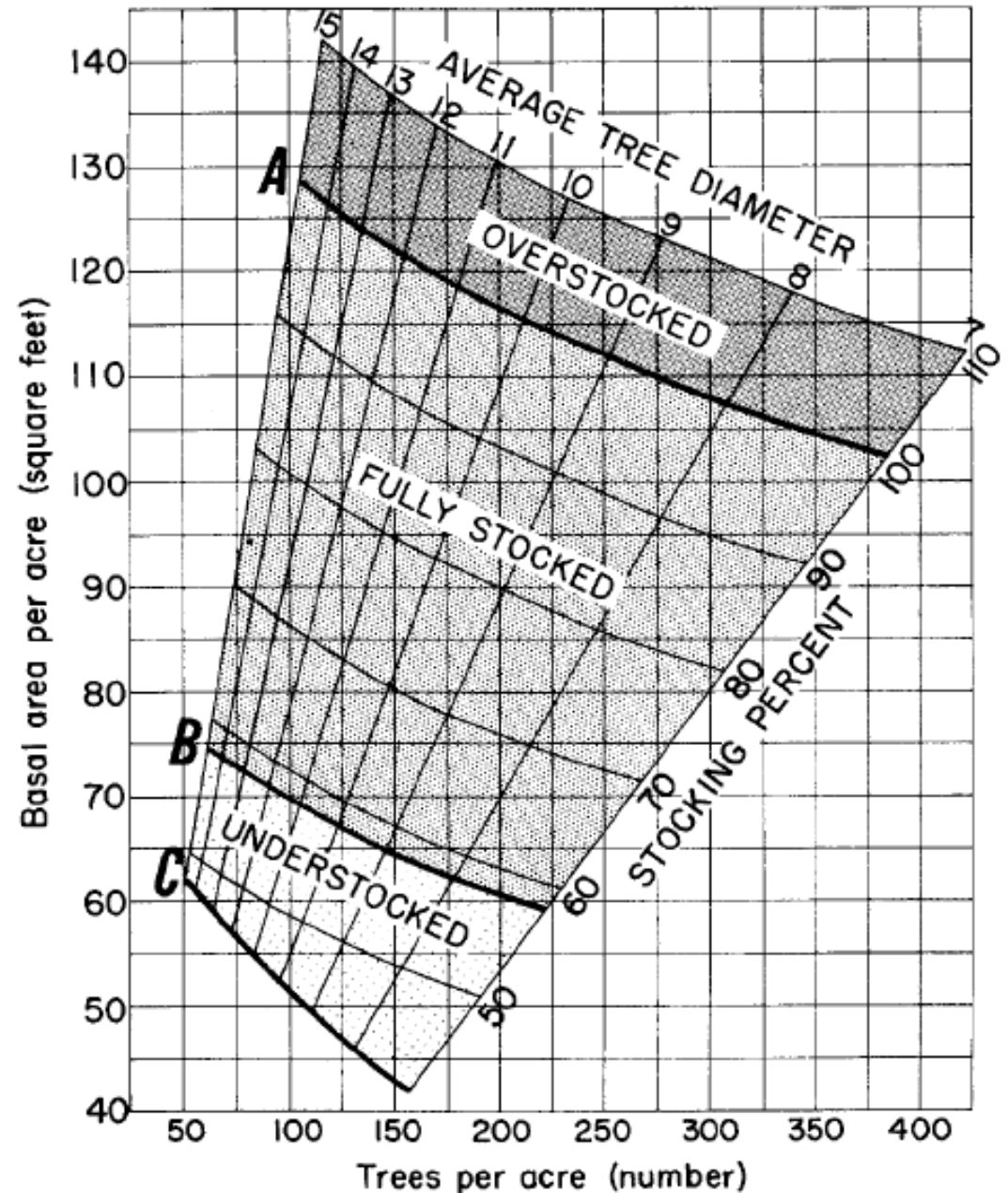


Basal Area (sq ft) per Acre RSD-17 Stand 4

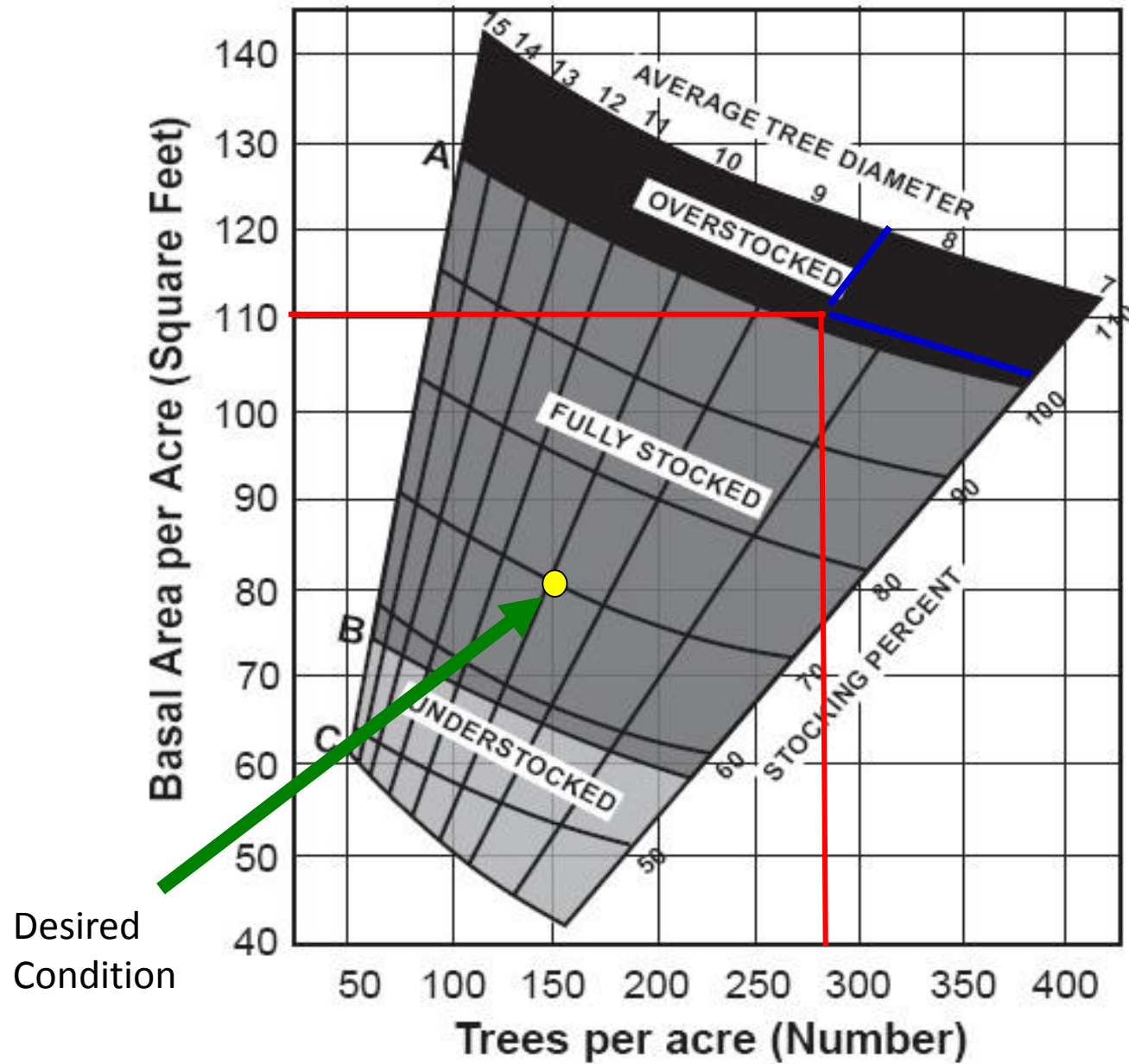


# Stocking

- Stocking Chart for Upland Hardwoods (Gingrich 1967)
- A graphical tool to allocate growing space on a relative basis
- Density and basal area are used to make decisions about need to manage



# Upland Central Hardwood Stocking Guide<sup>2</sup>





**Goal expressed:**

*Periodic harvests for continuous supply of oak lumber for HKHS tech class (~500 bf/yr).*



**Objective statement desired condition:**

*To address the goal of growing a wood supply for the future: Stand 4 is ideally stocked with 150 trees per acre of acceptable mixed oak growing stock, at 80 square feet of basal area per acre and average DBH of approximately 10 inches.*

# Recommendations or Prescriptions

**The list of actions necessary to take what you have to work with and produce the desired condition –**

*“In Stand 4 a thinning on approximately 10 acres at 5-year intervals is prescribed. Harvest approximately 110 stems per acre targeting undesirable growing stock, smaller diameter stems trees over 20 inches and non-oak species. Leave a minimum of two snags per acre, preferably cavity trees, and place brush in piles. The recommended activity will produce an estimated 2000 board feet of lumber or small logs per acre and two cords of fuelwood.”*

Basal Area Table (basal area/acre by diameter and species)

Species				Scarlet	Red	Sugar	Black			White	
DBH	White Oak	Red Oak	Black Oak	Oak	Maple	Maple	Birch	Beech	Hemlock	Pine	TOTAL
1						2					2
2					1						1
3					1		1	1			3
4					2	1	2	1	1		7
5							1				1
6						1			1		2
7			2				1				3
8	4		2	1	1		1				9
9	3		6					1			10
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15		2	5	2							9
16		3	4	1							8
17			3								3
18		1	2	1							4
19		1	1								2
20											0
21		1	2								3
22	1	1									2
23											0
24			1								1
25											0
26											0
27			1								1
28											0
29											0
30											0
TOTAL:	11	20	48	15	6	5	6	3	2	3	118

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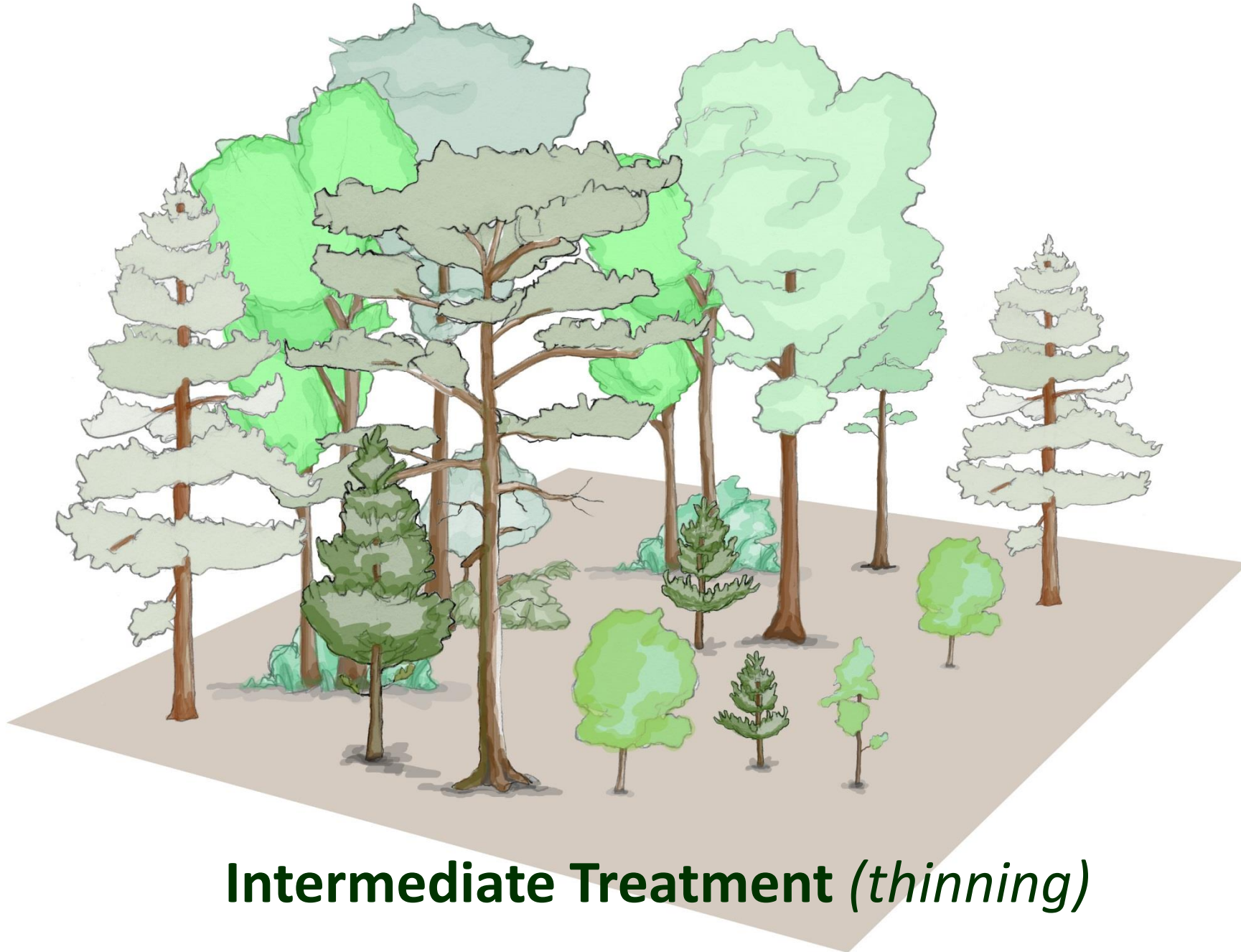
Stand Table (number of trees/acre by diameter and species)

Species	White			Scarlet	Red	Sugar	Black			White	
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12		1	1	1						1	5
13	1	1	4	1							8
14		2	5	2							9
15		2	4	2							7
16		2	3	1							6
17			2								2
18		1	1	1							2
19		1	1								1
20											0
21			1								1
22											1
23											0
24			.5								0
25											0
26											0
27			.3								0
28											0
29											0
30											0
TOTAL:	23	22	64	20	94	385	57	34	17	8	714

100

50

135



**Intermediate Treatment (*thinning*)**











Board Foot Volume Table (board feet/acre by diameter and species)

Species	White Oak	Red Oak	Black Oak	Scarlet Oak	Red Maple	Sugar Maple	Black Birch	Beech	Hemlock	White Pine	TOTAL
DBH											
1											
2											
3											
4											
5											
6											
7											
8											
9											
10	66	396	330	132		66				66	1056
11	70	70	279	279	70						768
12		74	74	74						74	296
13	73	80	291	80							524
14		200	501	200							901
15		212	525	212							949
16		387	546	129							1062
17			391								391
18		180	260	180							620
19		200	200								400
20											
21		262	275								537
22	318	318									636
23											
24			350								350
25											
26											
27			400								400
28											
29											
30											
TOTAL:	527	2379	4117	1286	70	66				137	8445 - 2000

UGS

500

1500

# Thinning to promote ecological objectives

- More recently has been an increased focus on using intermediate treatments to achieve ecological goals
- Within and alongside timber-focused silvicultural systems
- How could thinning (or other intermediate treatments) be used to promote non-timber objectives?
  - Change stand structure
  - Change tree structure/form
  - Change stand environment and ecosystem functioning
  - Promote tree growth and health
  - Increase ecosystem resilience

# Silvicultural Treatments (continued)

- **Regeneration Treatments** – lend their names to associated systems
  - Clear cutting
  - Seed tree
  - Shelterwood
  - Single-tree selection
  - Group selection

# Silvicultural systems and regeneration methods



Even-aged management



Uneven-aged management



# Common Even-Aged Systems



Clearcut



Seed Tree



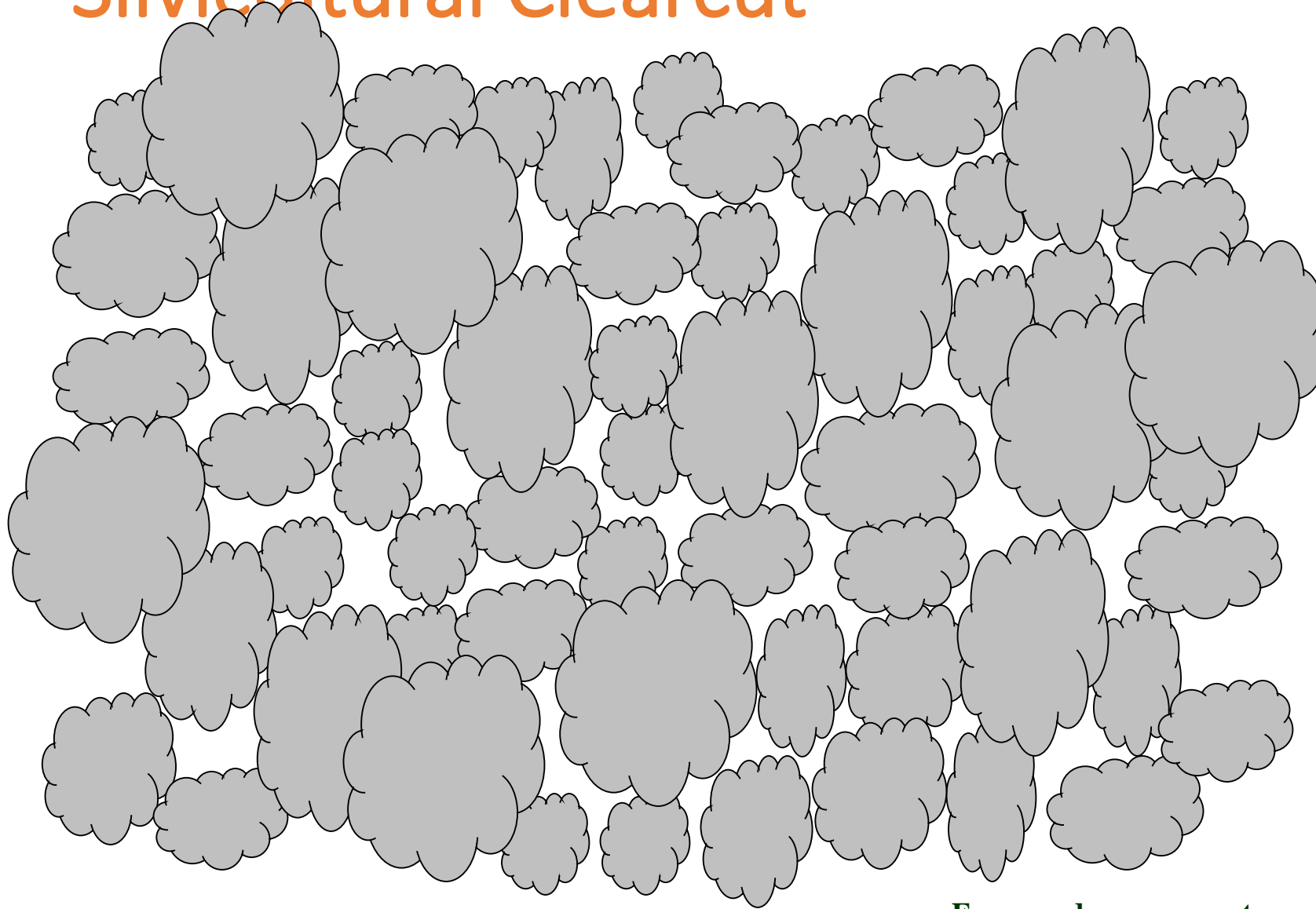
Shelterwood





Silvicultural clearcut

# Silvicultural Clearcut



**Even-aged management**







## Patch clearcutting

Stand is regenerated in a series of clearcuttings made in patches

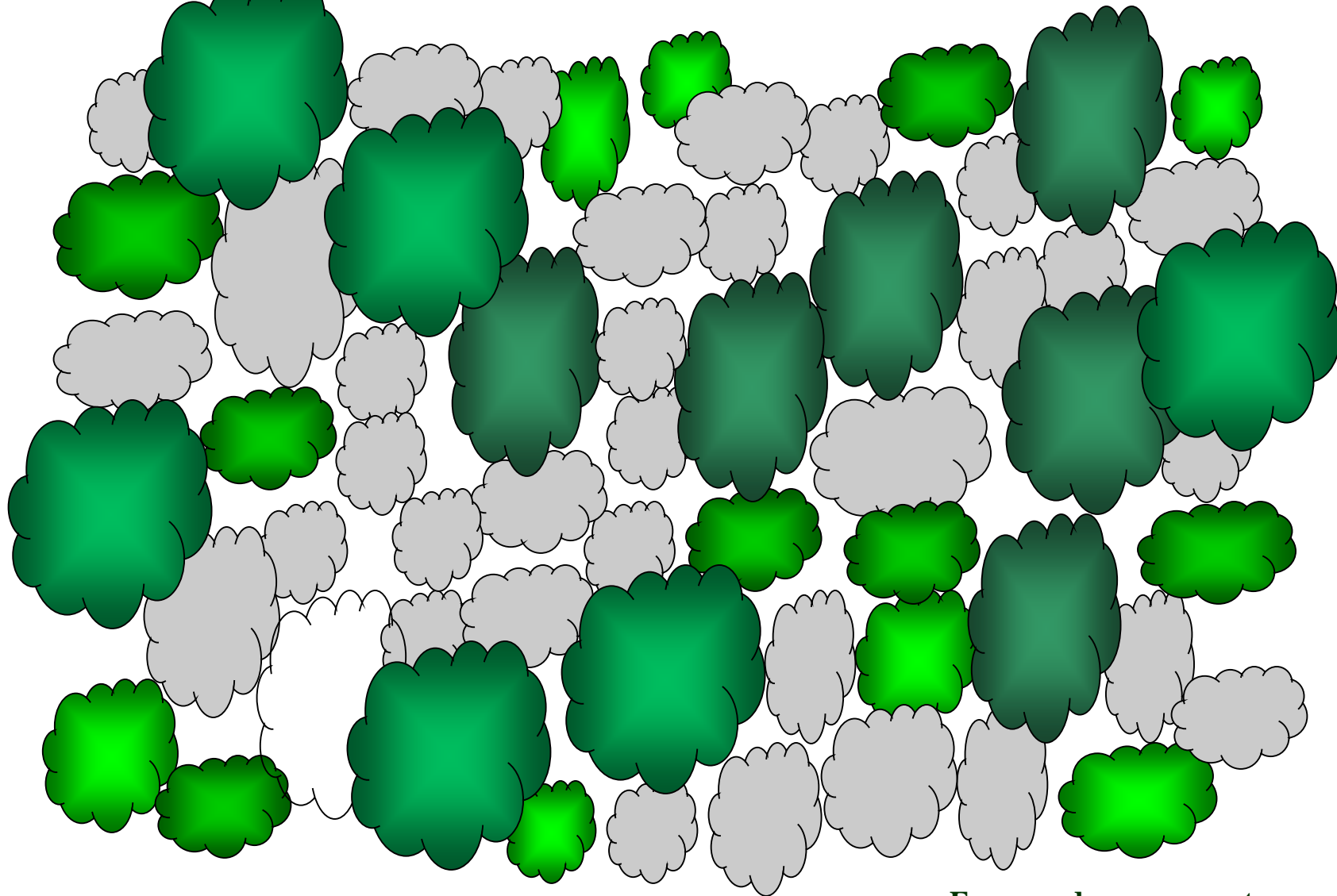
Patch size influences light availability within the patch and should be chosen to match species silvics





Shelterwood method

# Shelterwood



**Even-aged management**









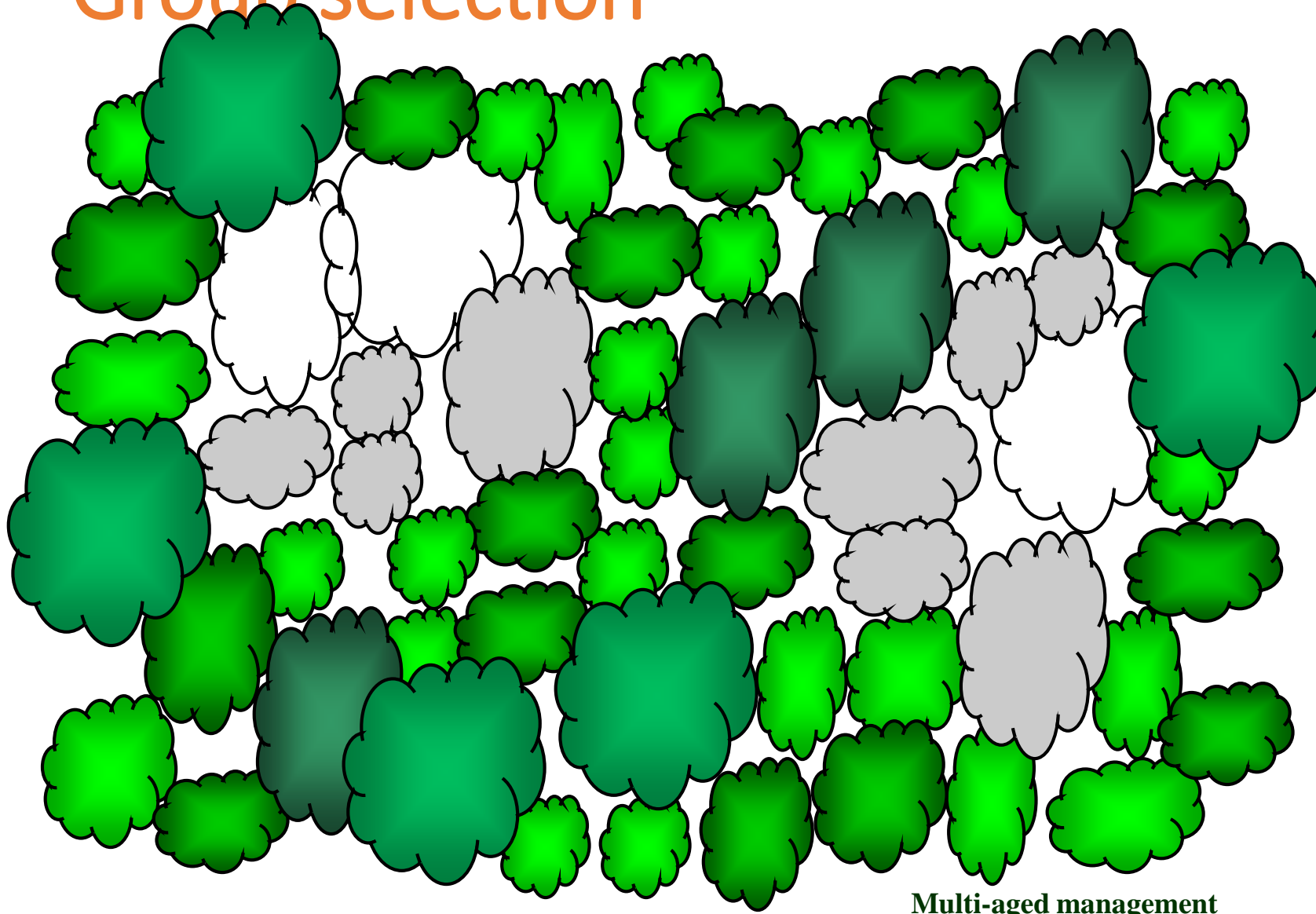




Group selection



# Group selection



**Multi-aged management**





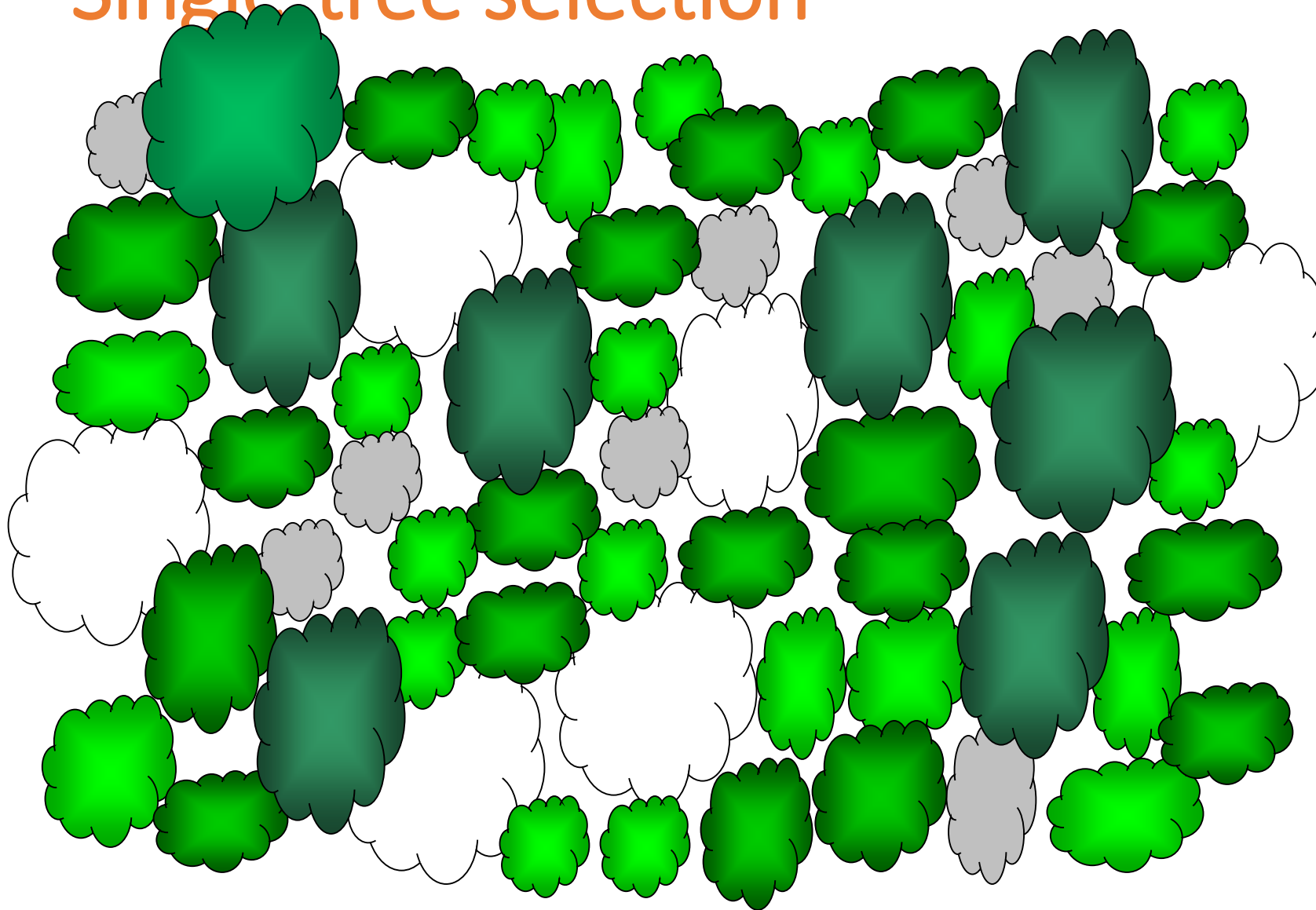




Single tree selection

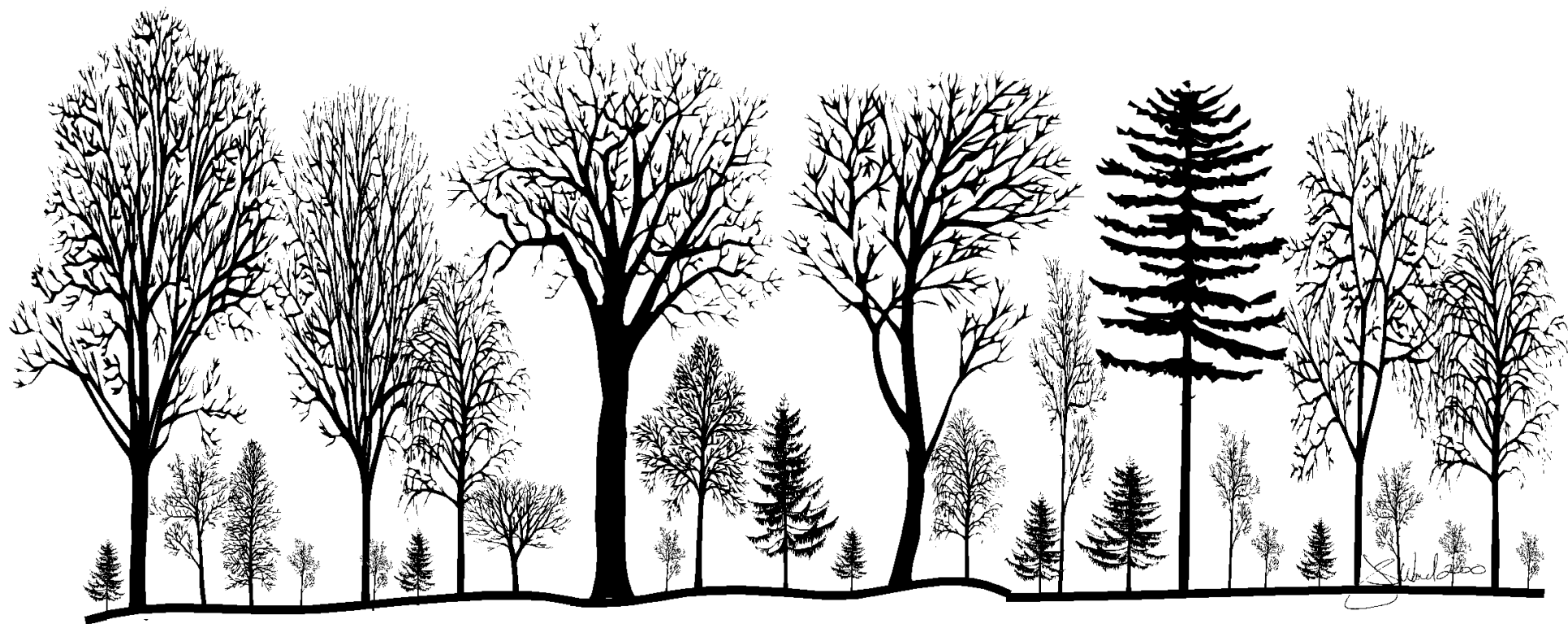


# Single-tree selection



**Uneven-aged management**

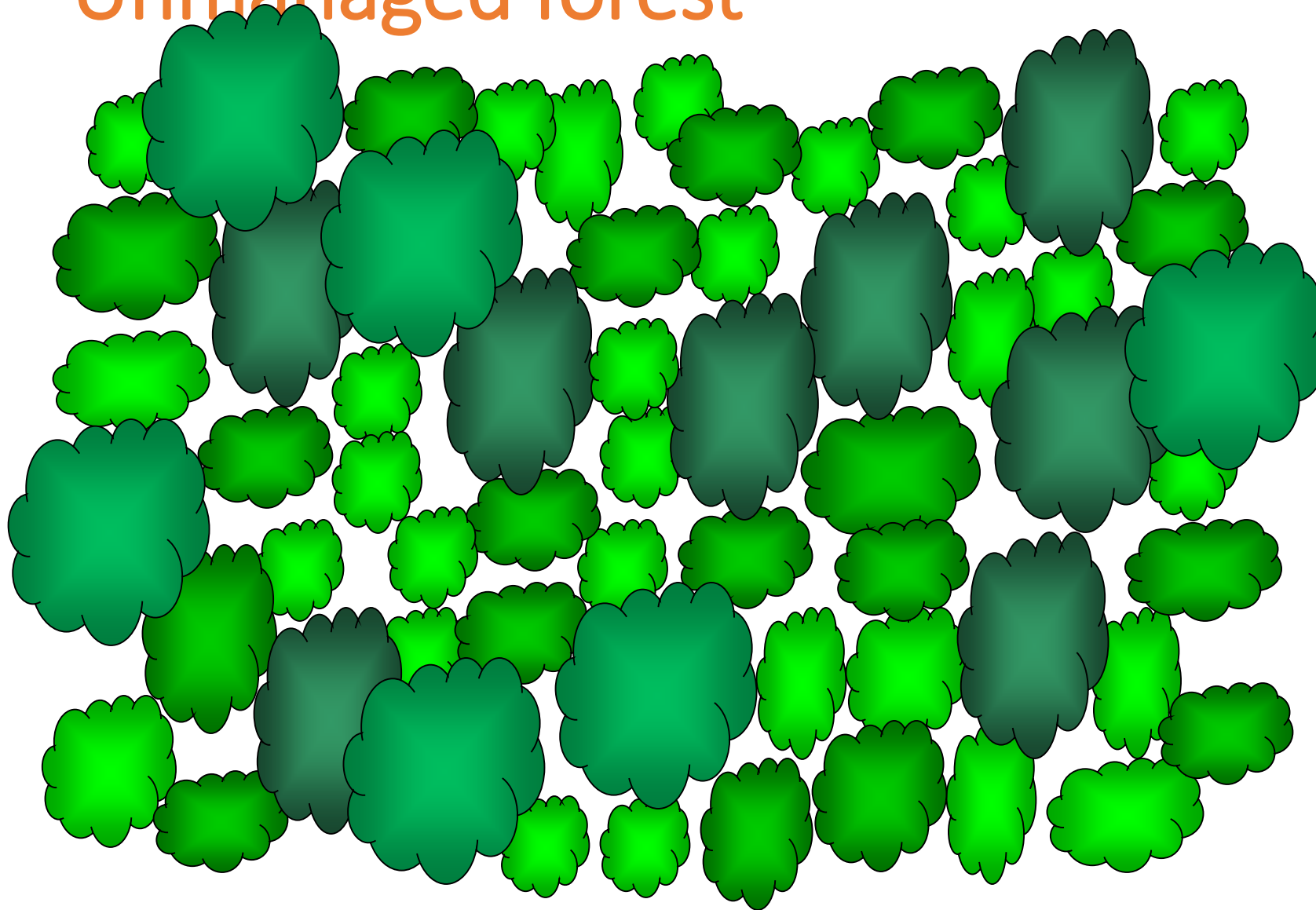




Unmanaged forest



# Unmanaged forest

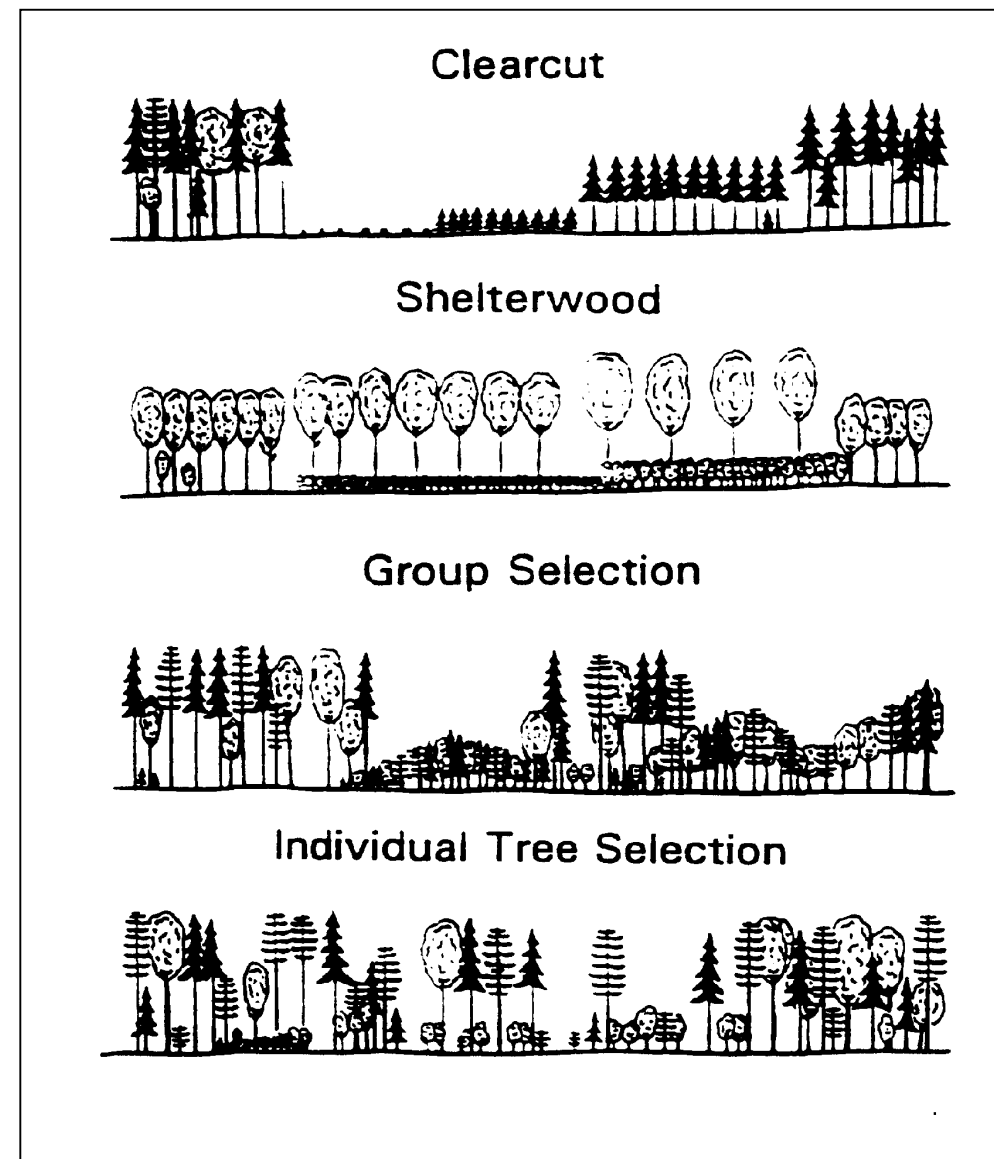
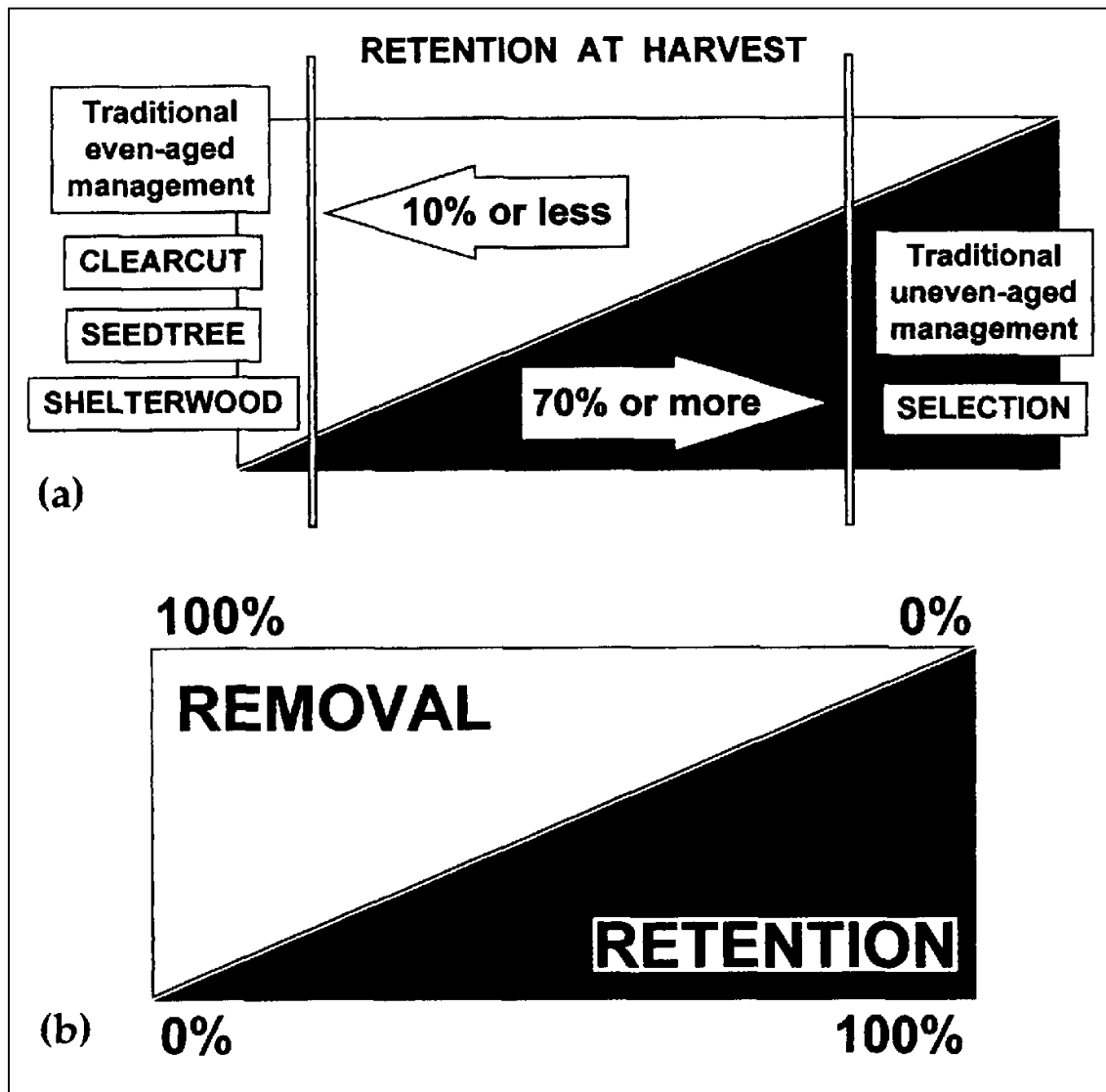


**Uneven-aged management**











# Silvicultural factors in choosing system

- Demands of regeneration - species of interest and potential competitors
  - Seed production, germination, early growth
- Demands of established trees
  - Spacing, shade tolerance
- Characteristics of retained trees
  - Stability, growth
- Capacity for multiple entries
  - Potential for damage to regeneration
  - Potential for increase in value for retained trees

# Deciding on a Silvicultural System

System often determined by shade and exposure tolerance of regeneration

Protection Needed	Exposure Tolerant		
Shade Tolerant	Shade Tolerant	Mid-tolerant	Shade Intolerant
ST Selection	ST Selection	Shelterwood	Clearcutting
Group Selection	Group Selection	Seed Tree	Seed Tree
Shelterwood	Shelterwood	Clearcutting	Shelterwood
	Seed Tree	Group Selection	
	Clearcutting		

# Other factors in choosing system

- Societal and aesthetic demands
  - Potential responses
  - Minimum tree cover, tree size, etc.
- Financial considerations
  - Value produced by different options – balance of product types
- Habitat and ecosystem function considerations
  - Tree cover and retention
  - Size distributions and importance of large trees
- Site considerations
  - Potential for damage to site with intensive harvest or multiple entries



# Types of Even-aged Systems

- Differentiated based on levels of residual canopy left on the site in the initial harvest
- Shelterwood > Seed Tree > Clear-cut
- Also the **silvicultural** reasons that the canopy is retained
  - Shelterwood – shelter
  - Seed Tree – seed source
  - Clear-cut – none!
- But in each system the traditional eventual endpoint is an open canopy – to allow for regeneration of shade intolerant trees

# Uneven-aged Regeneration Systems

- Uneven-aged regeneration systems often referred to as selection systems
  - Not "selective" cutting
  - “Selective” logging could be referring to a thinning, to a shelterwood establishment cutting, or to a high-grading cut



# Characteristics of Uneven-aged Systems

- Selection methods produce an uneven-aged stand (with at least 3 age classes or distinct cohorts)
- For regeneration, trees are harvested as individuals or in small groups
  - Single-tree selection method: removing individual mature trees more or less uniformly across a stand
  - Group selection method: removing mature trees in small groups or clusters



# Characteristics of Uneven-aged Systems

- Maintains a continuous high forest cover
- Typically emphasizes the production of sawtimber sized trees
- A selection system can be designed to obtain a sustained yield at recurring short intervals

# Beyond Traditional Silviculture





# From multiple use management (1960s-1970s) ...



**Timber production**



**Wildlife (Game animals)**



**Recreation**



... to Ecosystem Management (since 1992)...





## ... to Managing for Complexity and Resilience





# Ecosystem Management

- Maintain habitat and biodiversity at a regional/landscape scale
- Ecosystem functions – especially watershed-related





# Ecological Forestry

- Goal is maintaining or enhancing ecological complexity in a stand, as determined by structural and compositional characteristics
- Systems and treatments based on **emulation of natural disturbance regimes** and stand processes
  - Multiple species
  - Multiple age classes
  - Spatial heterogeneity
  - Habitat features

