



# UNEVEN-AGED MANAGEMENT

## NORTHWEST CERTIFIED FORESTRY

Rolf Gersonde, 6/6/2015

# Uneven-aged Management in 90 Minutes

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- **Silviculture Background**
- **Forest Ecology**
- **Management Tools and Stocking Control**
- **Multi-aged Management Regime**
  - **Group Selection Example**
  - **Single Tree Selection Example**
- **Tools for Assessment and Management**
- **Operations**

# What is Uneven-aged Management?

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Even-aged “age-class” Forestry

GROUP SELECTION

SINGLE TREE SELECTION



Uneven-aged Management System







## Managing Multi-aged Stands







**Alfred Möller, 1922  
“Dauerwald”**

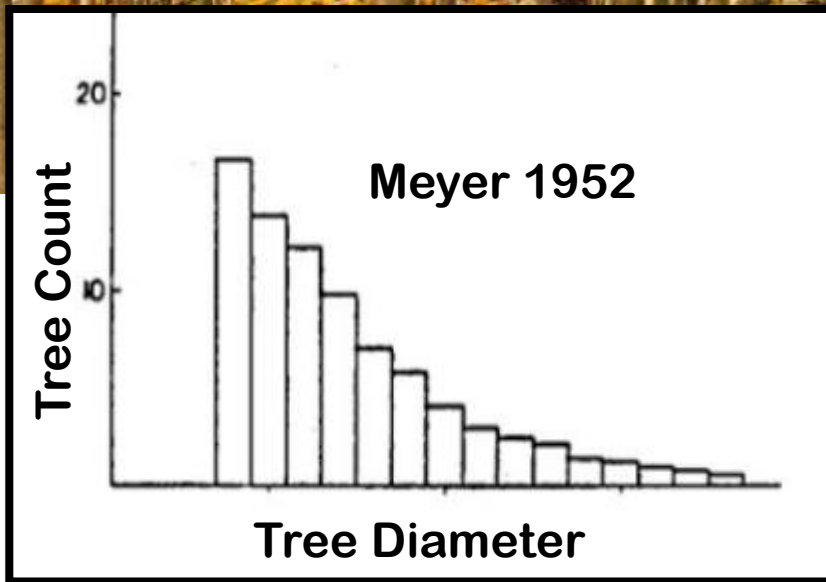
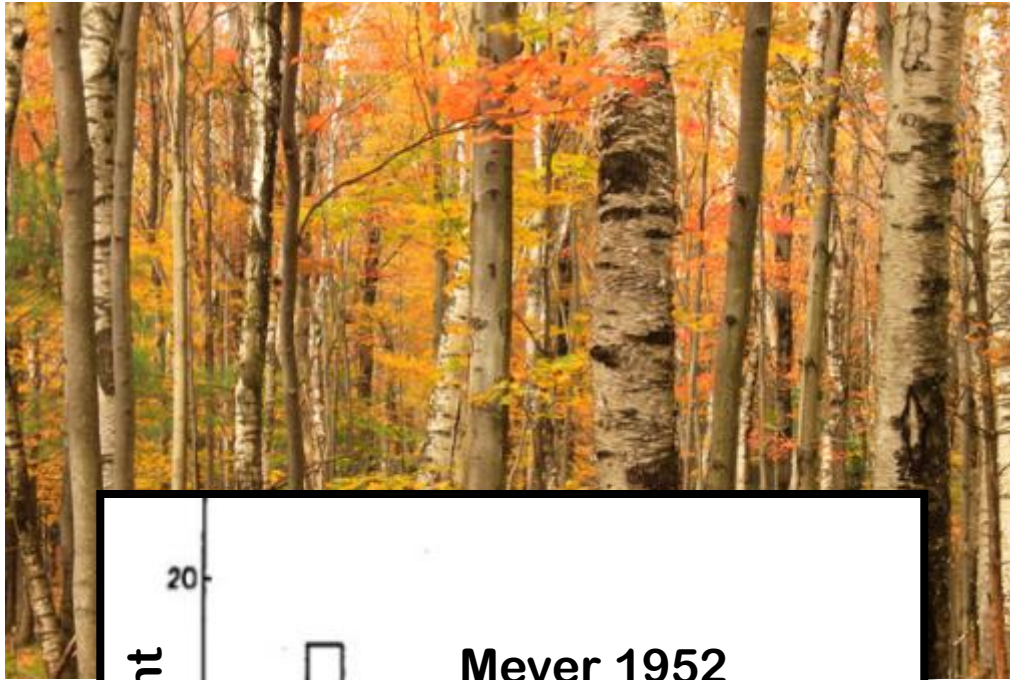
**Continuous Cover  
Forestry**



# Ecological Basis

- Diameter distribution of natural stands
- Small-scale disturbance regime

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# History of Uneven-aged Management in the Pacific Northwest

Kirkland and Brandstrom 1936  
Leo Isaac 1956

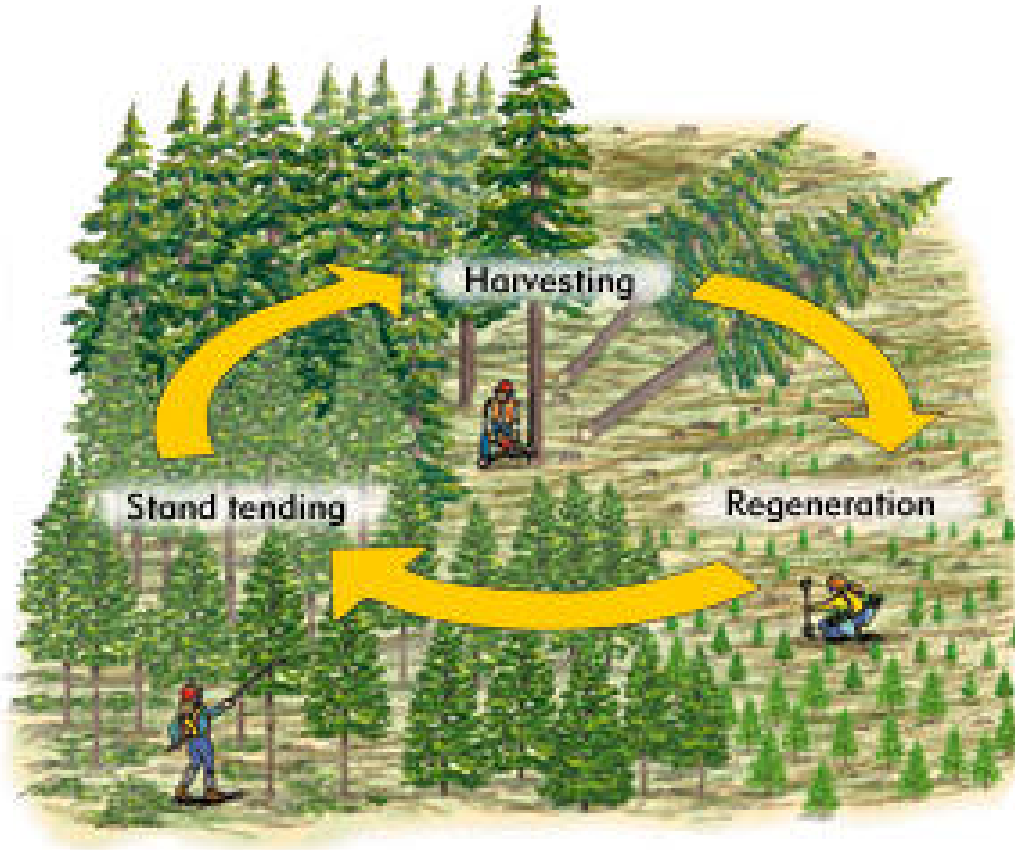
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# Silvicultural System –

System of coordinated regeneration, tending, control, and harvest treatments

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## Even-aged System

- Clear Cut
- Seed Tree
- Shelterwood
- Thinning

## Two-aged System

- Variable Retention
- Coppice with Reserves

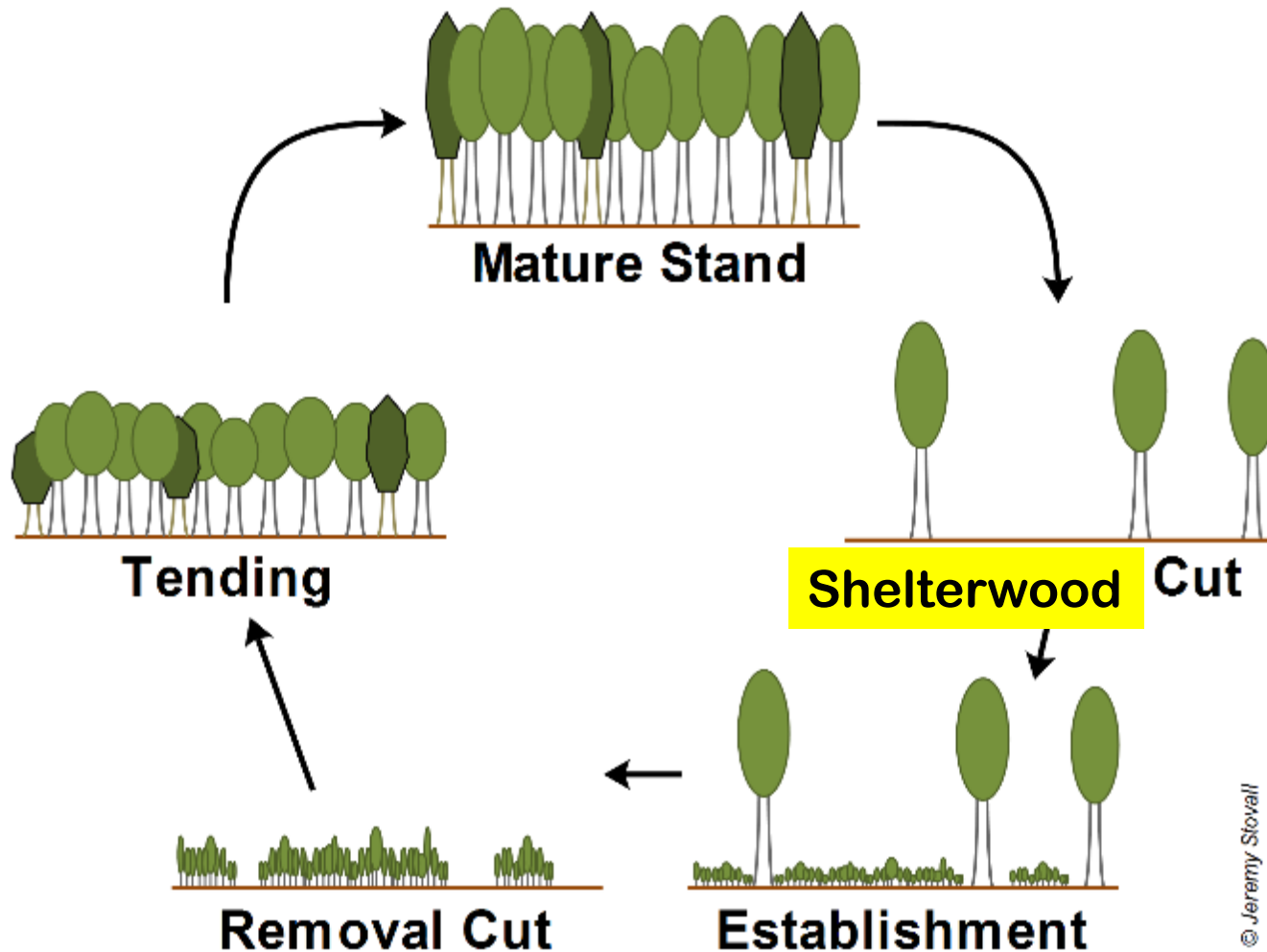
## Uneven-aged system

- Group Selection
- Thinning
- Single Tree Selection



# Seed-Tree and Shelterwood Regeneration Methods

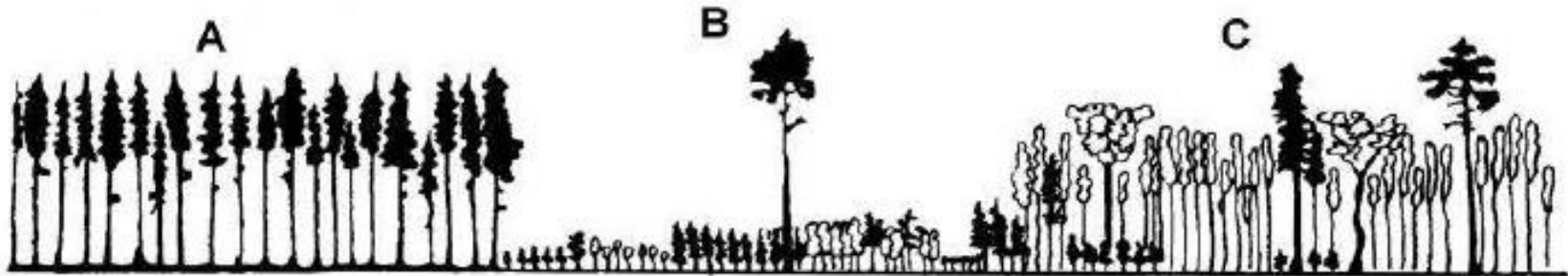
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# Continuum of Silvicultural Approaches

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INITIAL CONDITION



AFTER 30 YEARS



AFTER 60 YEARS



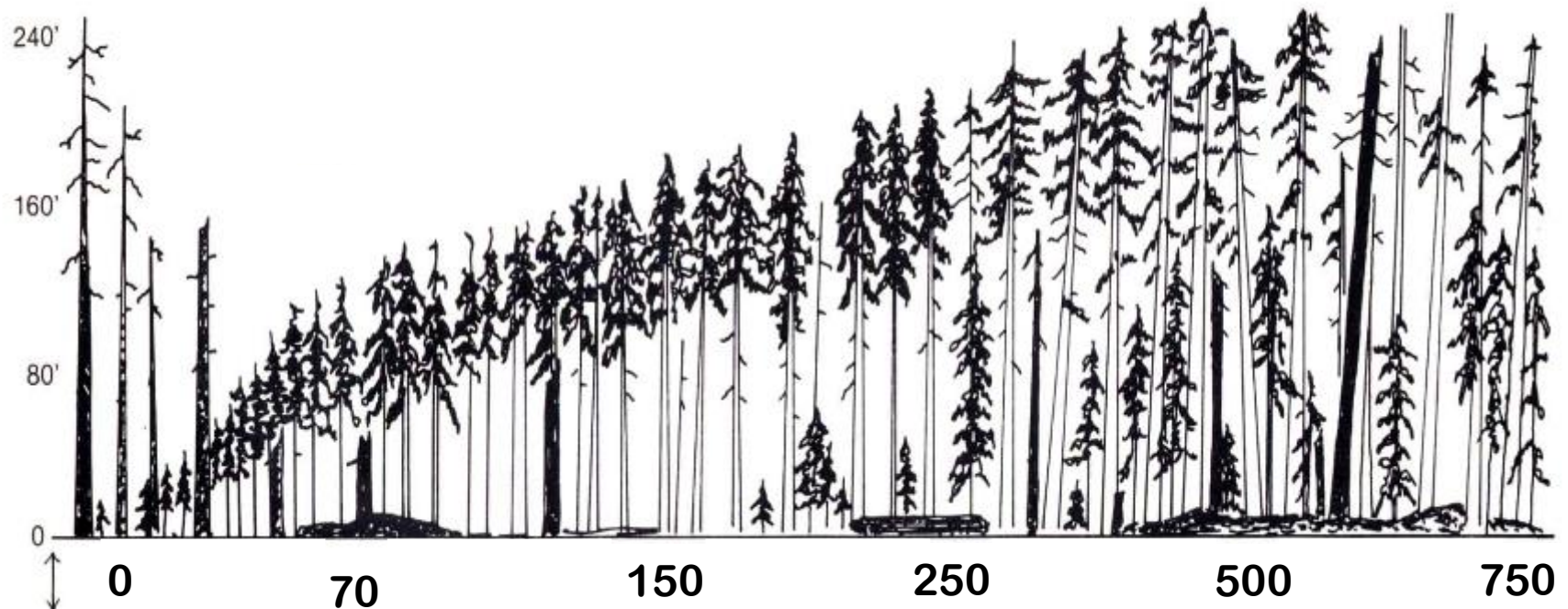


# Forest Stand Dynamics

Stand development stages, disturbance dynamics, habitat

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Franklin and Van Pelt 2004



**Stand Initiation**

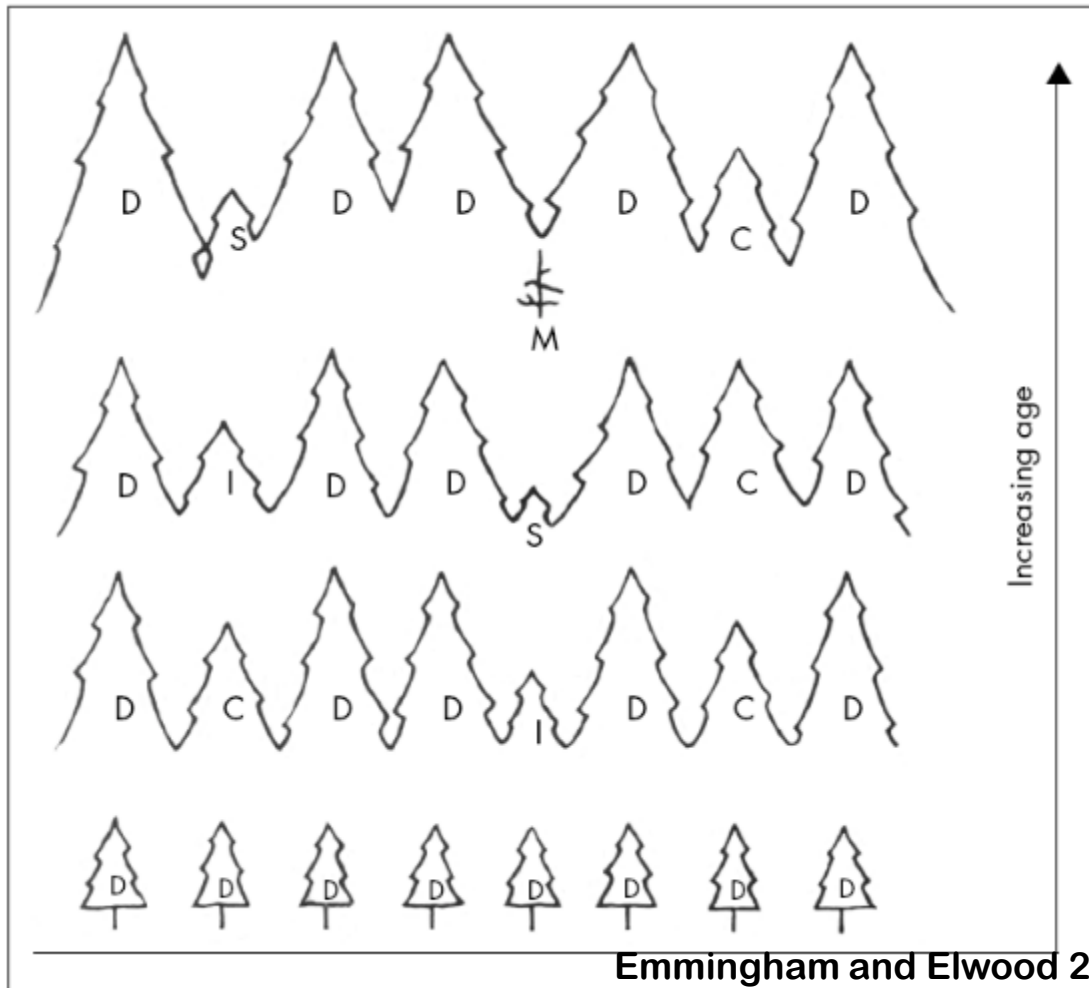
**Stem Exclusion**

**Understory  
Re-Initiation**

**Diversification – Vertical - Horizontal**

# Crown Differentiation

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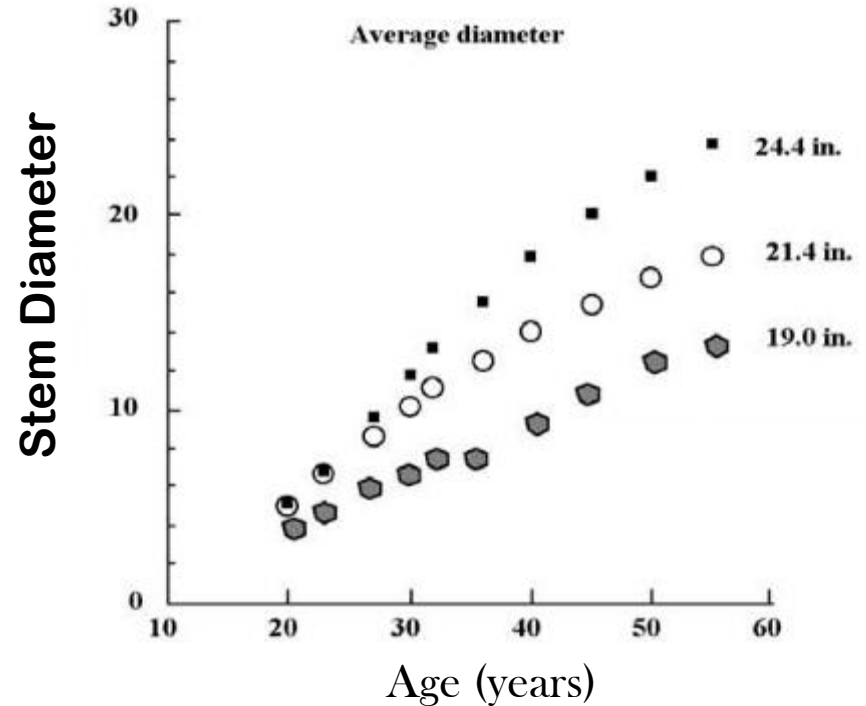
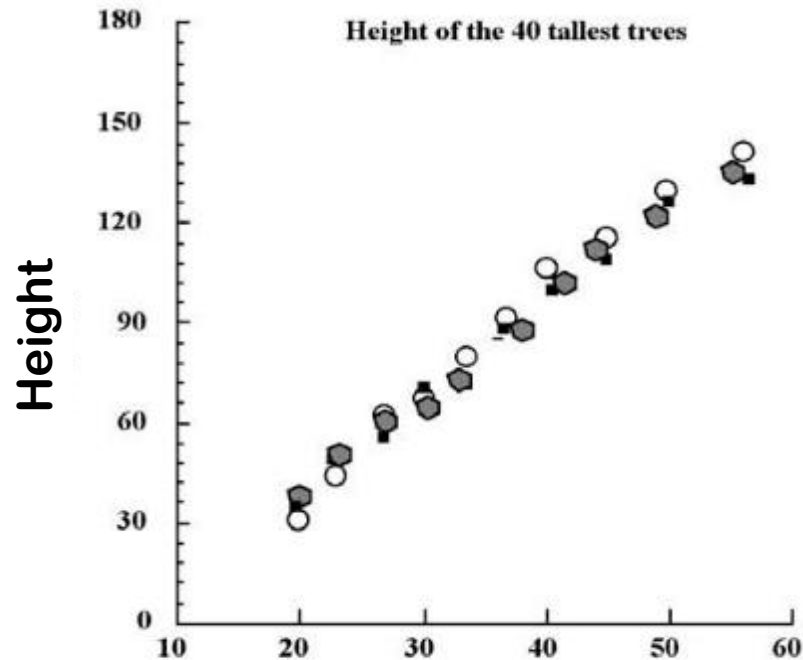
**D – Dominant**  
**C – Co-dominant**  
**I – Intermediate**  
**S – Overtopped**  
**M – Mortality**

Emmingham and Elwood 2004



# Height vs. Diameter Growth

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- Douglas-fir grown at three different densities, from Marshall and Curtis, 2002

# Competitive vs. Agent Mortality

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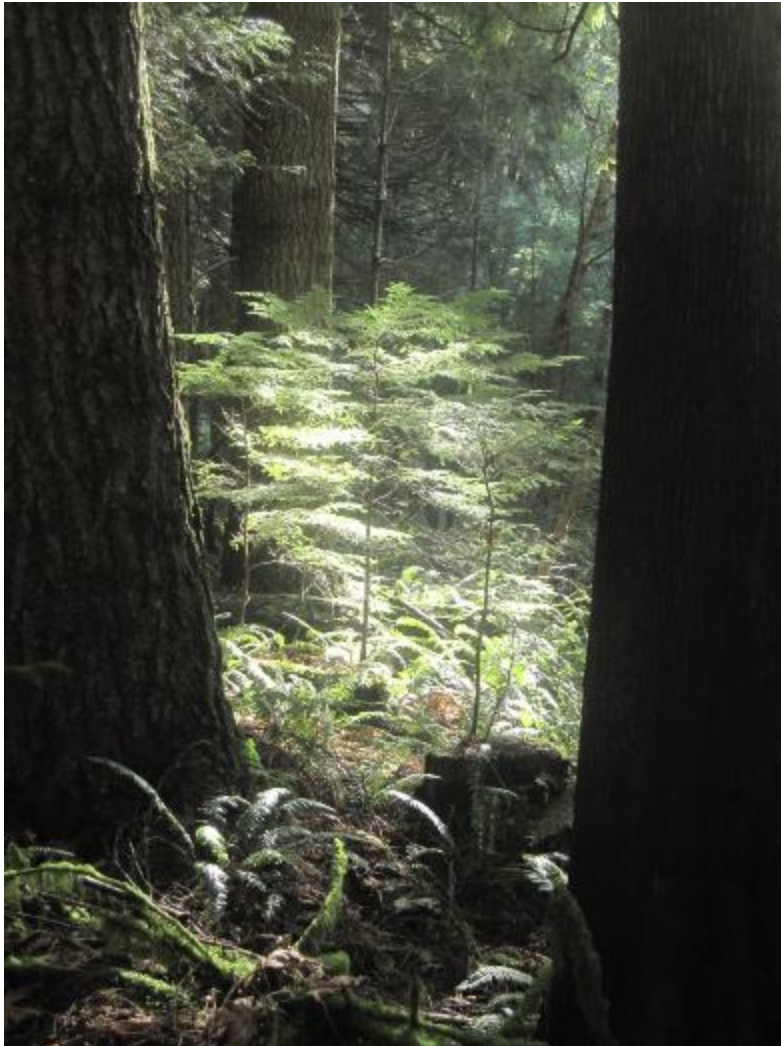




# Natural Regeneration

## - Understory Establishment Stage

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- **Seed Source**
  - Species, seed year, predation
- **Environment**
  - Temp, water, light
- **Seed bed**
  - Soil, competition, mycorrhiza

# Understory Development – Identify Shade Tolerance

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**Grand fir**



**Western hemlock**



**Douglas-fir**



**Western white pine**

# Shade tolerance – Ranking of western tree species (Daniel et al. 1979)

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<b><u>Very tolerant</u></b>	Western hemlock Pacific yew Pacific silver fir Vine maple
<b><u>Tolerant</u></b>	Western redcedar Grand fir Sitka spruce
<b><u>Intermediate</u></b>	Big-leaf maple Douglas-fir Western white pine
<b><u>Intolerant</u></b>	Ponderosa pine Lodgepole pine Red alder
<b><u>Very intolerant</u></b>	Cottonwoods Larch



# Understory Growth – Morphological Plasticity

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Noble fir



Pacific silver fir



Western hemlock

- Sun and shade foliage
- Terminal vs. lateral growth
- Apical dominance



# Mixed-species Forests

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# Mixed-Species Stands

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- **Species specific**
  - ▣ Growing space
  - ▣ Height growth
  - ▣ Stratification
  - ▣ Shade tolerance
  - ▣ Senescence
  - ▣ Facilitation
  - ▣ Forage

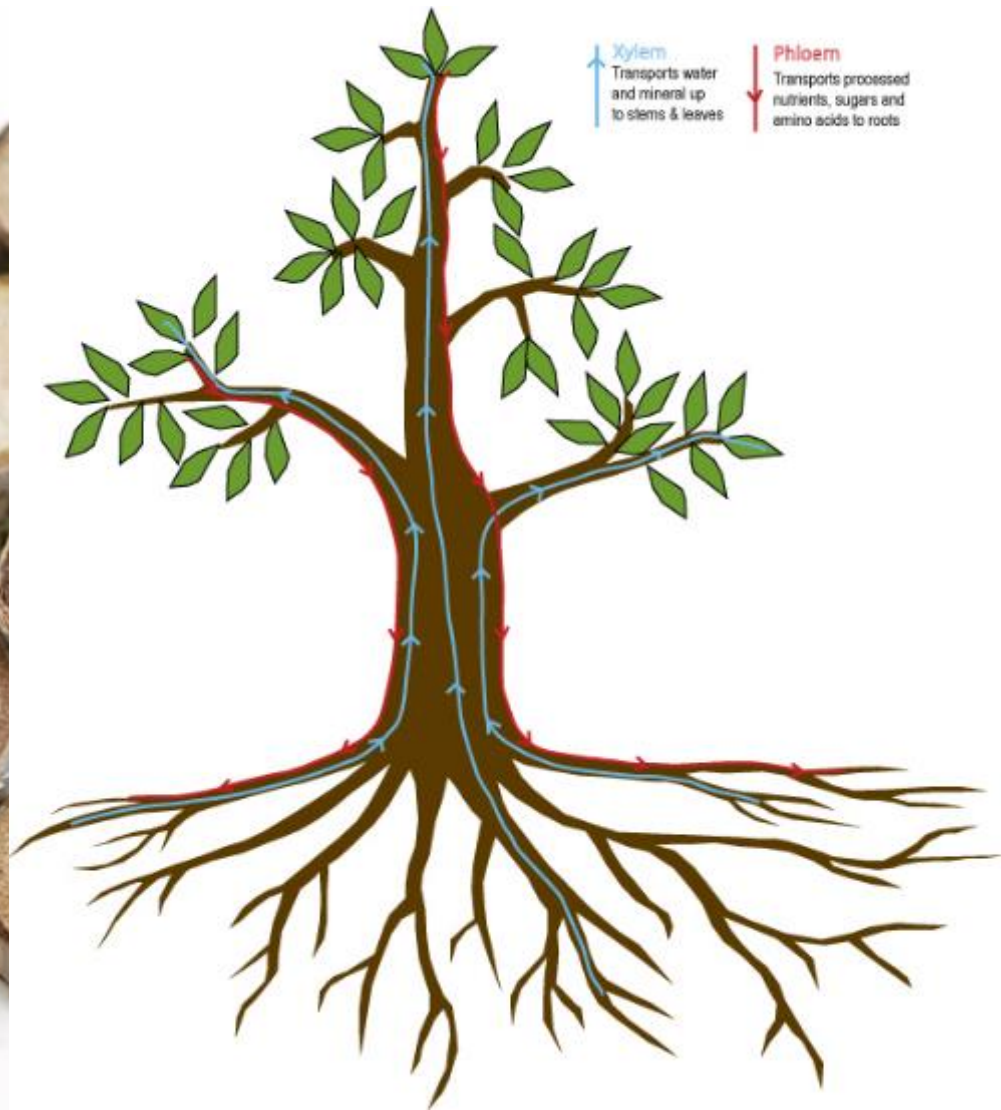




# Growing Space

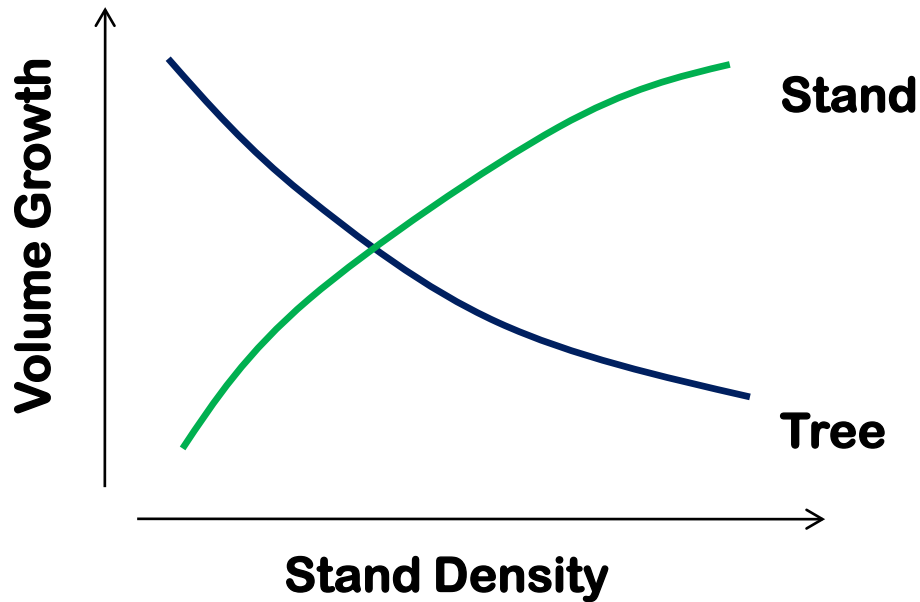
- Resources, leaf area, basal area, and allocation

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# Growing Space Allocation – Trees versus Stands

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# Growing Space Allocation

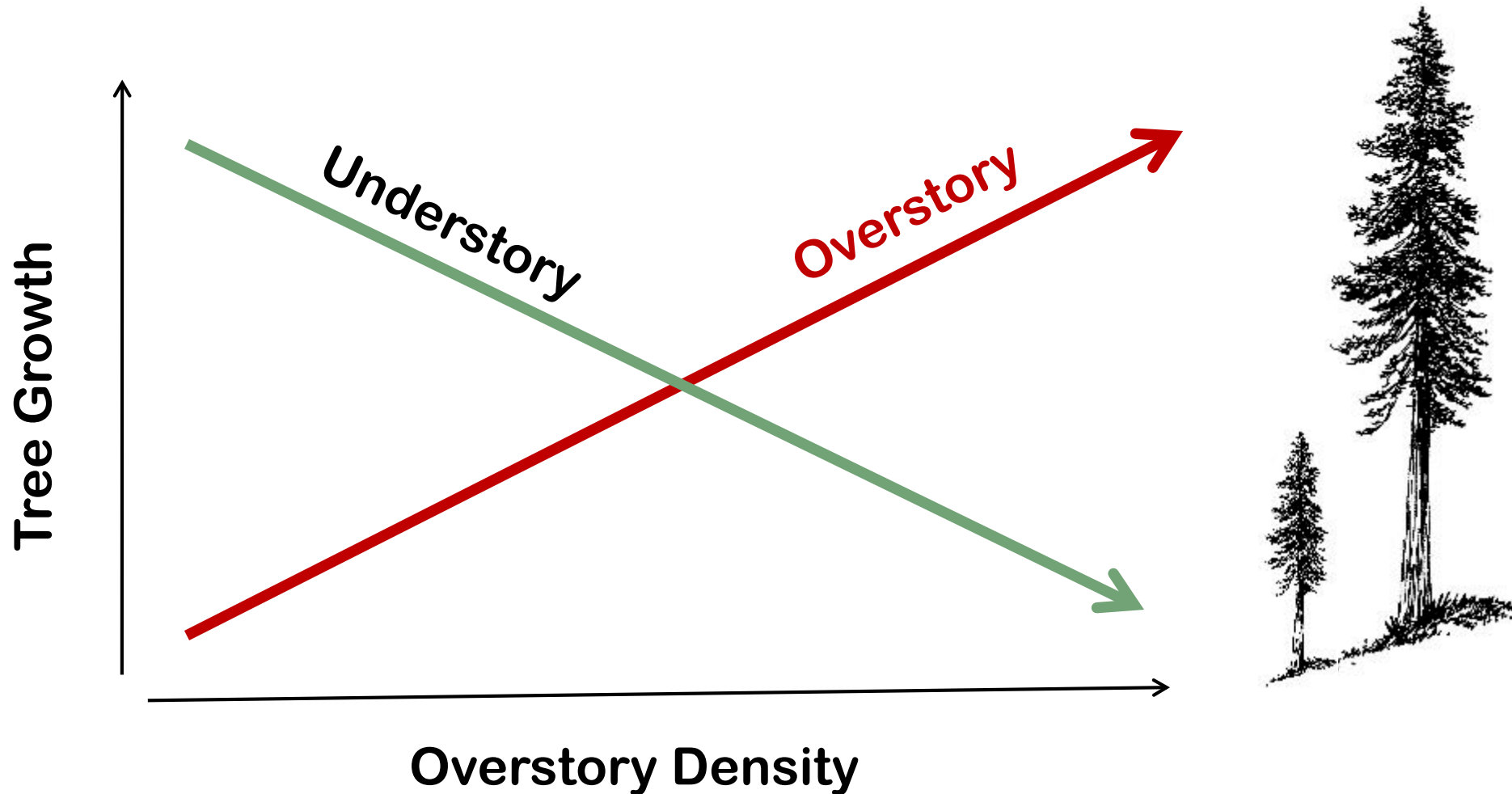
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# Growing Space Allocation – Overstory versus Understory

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# Managing Uneven-aged Stands

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**Manage stand density to:**

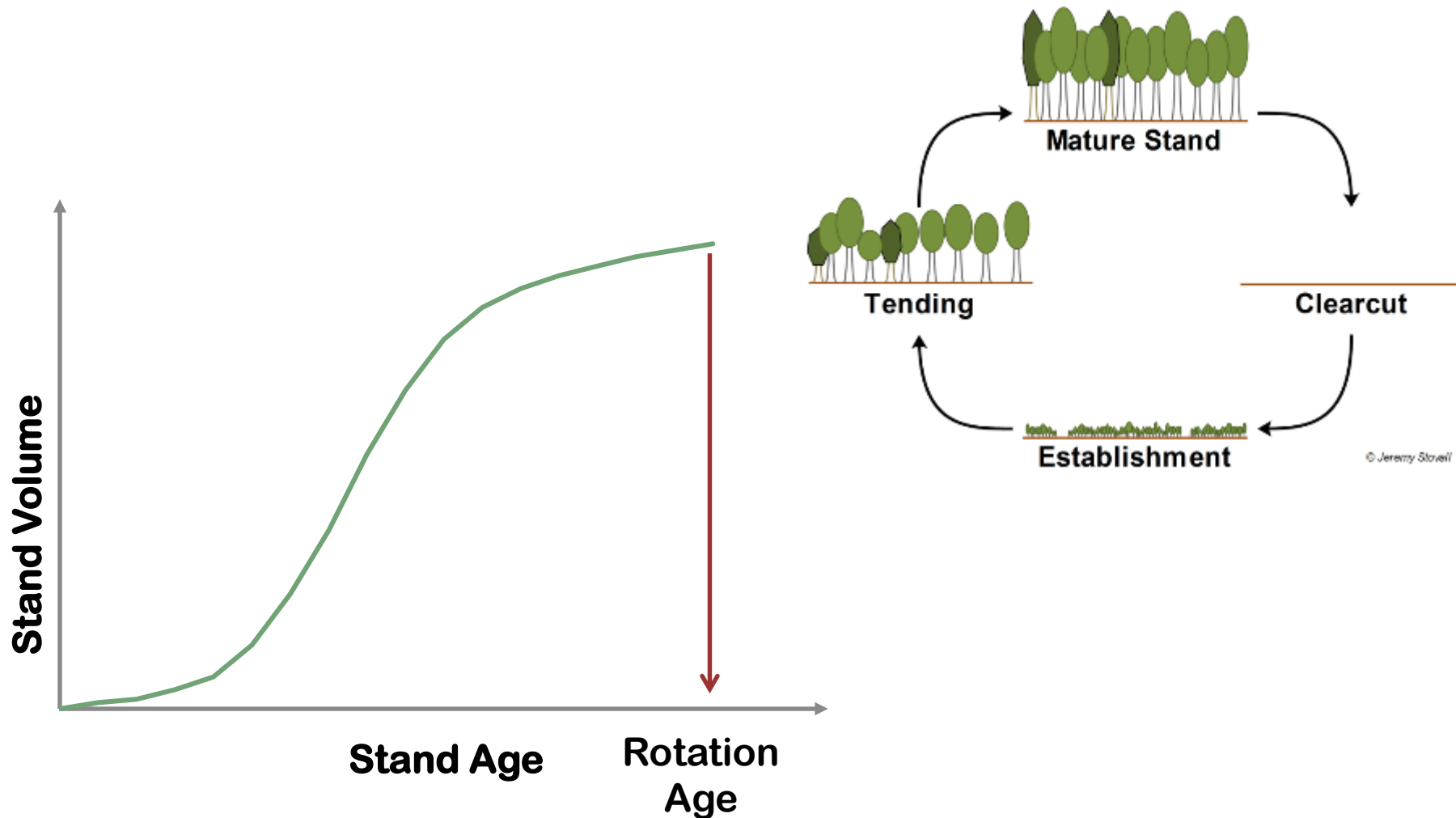
- 1. Sustain growth of all stand components**
- 2. Maintain stand structure**
- 3. Replace tree mortality and harvest through regeneration**

**# Sustainability Indicators**

**Transformation**

# Stand Volume and Rotation in Even-aged System

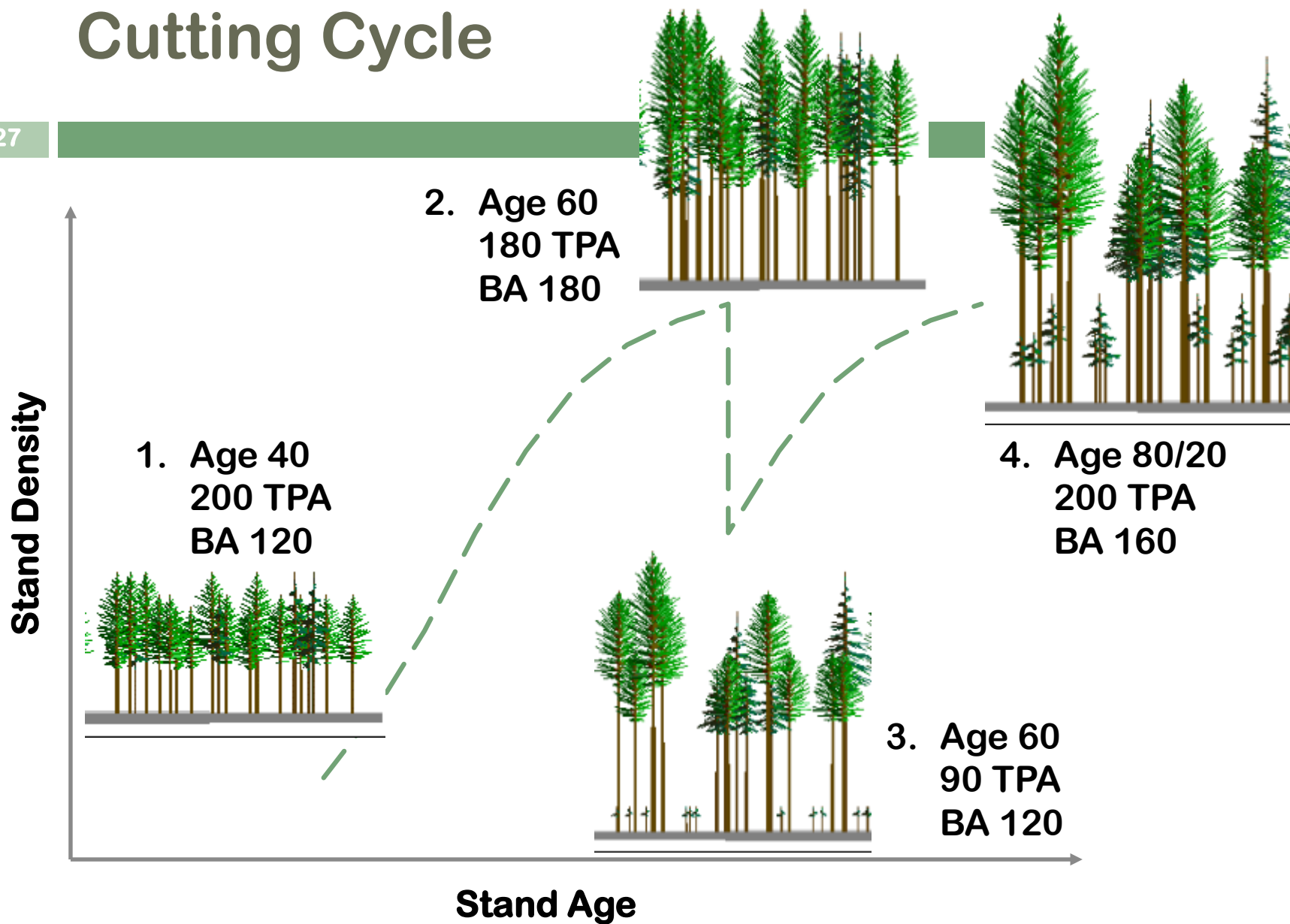
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# Cutting Cycle

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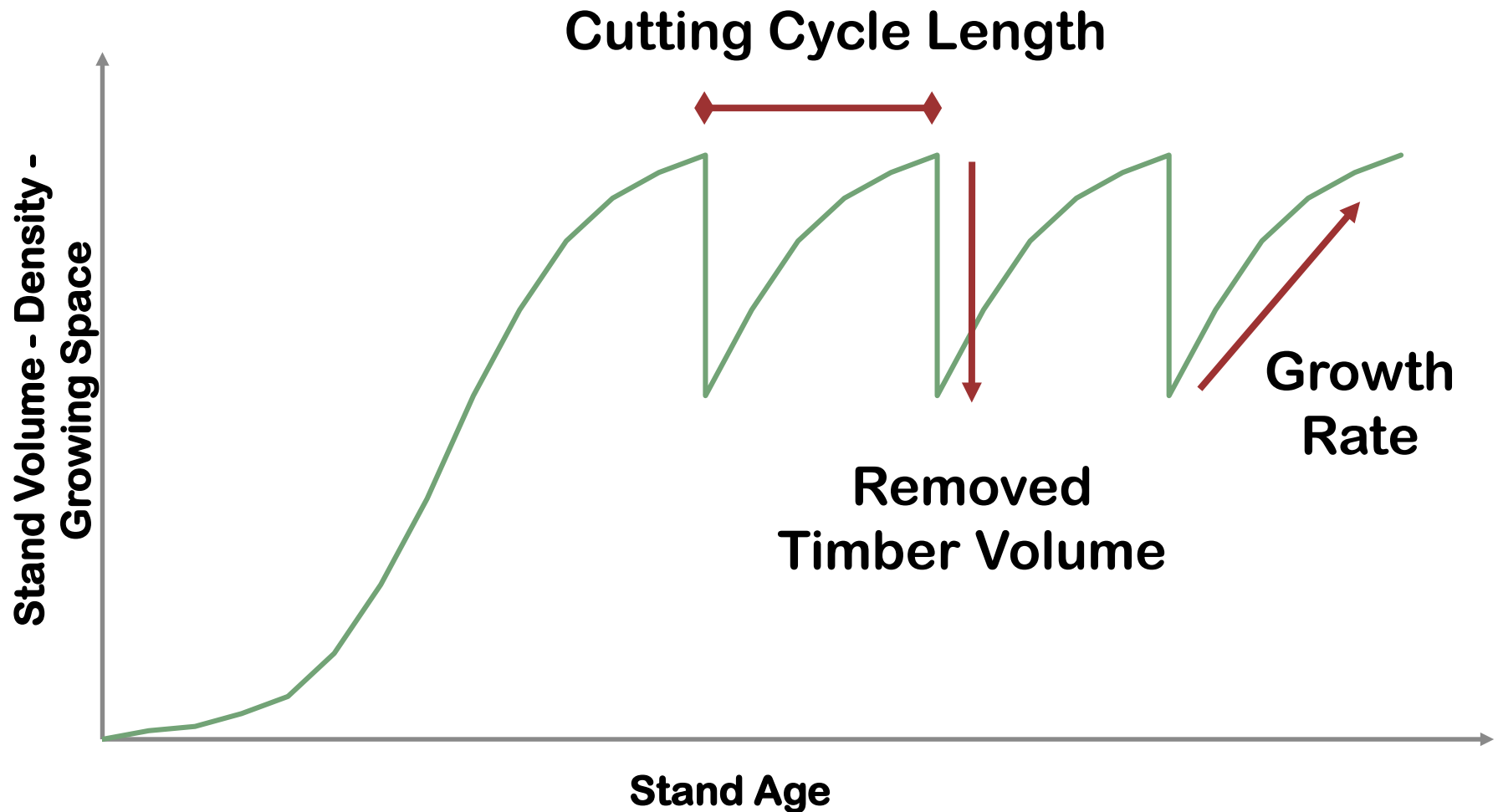




# Cutting Cycle

– cutting cycle length depends on cutting intensity and growth rates

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# Yield Tables for Even-aged Stands

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DNR Report No. 41  
October 1980

## Empirical Growth and Yield Tables for the Douglas Fir Zone

Charles J. Chambers  
Division of Management Services

STATE OF WASHINGTON  
DEPARTMENT OF NATURAL RESOURCES  
Olympia, Washington 98504

2nd Printing January 1983

Brian Boyle  
Commissioner of Public Lands

Russell W. Cahill  
Supervisor

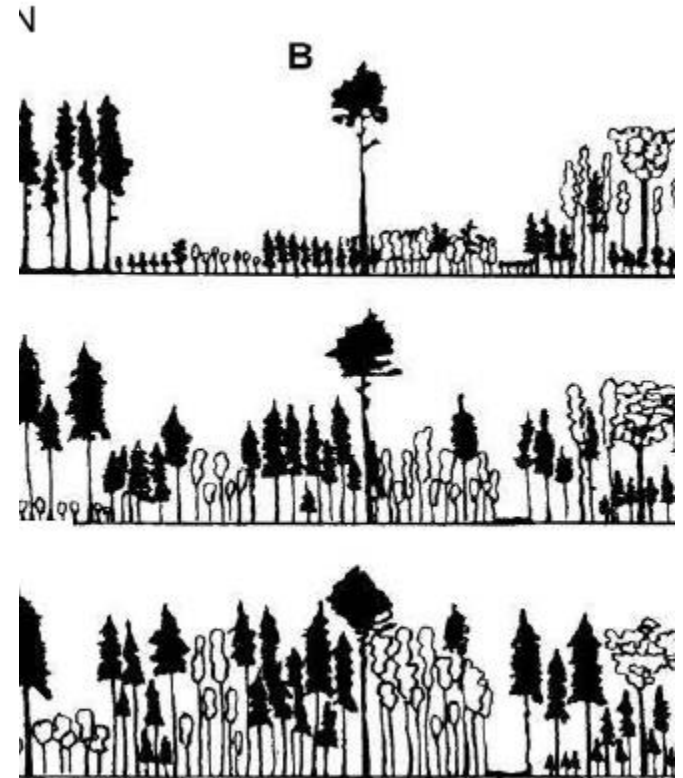
**Table 9 Scribner Board-Foot Volume Per Acre  
(7.0 Inches DBH and Larger)  
6-Inch Top, 32-Foot Logs**

Total Age	50-Year Site Index								
	70	80	90	100	110	120	130	140	150
PNBA = 60%									
30	233	741	1186	2015	2697	3968	4930	6702	7947
40	1800	2979	4148	5939	7540	9955	11949	14954	17286
50	3902	5941	8021	10856	13486	17027	20094	24232	27629
60	6258	9211	12267	16138	19813	24414	28523	33673	38053
70	8591	12457	16499	21368	26067	31649	36739	42779	48036
80	10690	15440	20453	26273	31957	38447	44448	51269	57293
90	12396	17988	23945	30669	37301	44636	51485	58998	65691
100	13595	19976	26844	34433	41981	50114	57764	65904	73192
PNBA = 80%									
30	433	1103	1701	2805	3723	5418	6708	9066	10734
40	2443	4009	5569	7948	10082	13291	15948	19942	23049
50	5195	7904	10671	14442	17942	22455	26739	32252	36778
60	8352	12292	16361	21529	26426	32572	38050	44935	50778
70	11590	16776	22176	28705	34981	42469	49267	57372	64392
80	14651	21068	27793	35638	43253	51994	60023	69206	77258
90	17341	24954	32987	42101	51013	60929	70110	80250	89201
100	19507	28274	37592	47935	58112	69147	79417	90427	100172
PNBA = 100%									
30	626	1458	2210	3590	4744	6861	8479	11421	13509
40	3069	5018	6966	9929	12593	16587	19902	24876	28754
50	6445	9816	13262	17957	22320	28193	33288	40164	45814
60	10366	15277	20349	26797	32906	40583	47423	56031	63330
70	14461	20947	27691	35863	43706	53085	61584	71741	80520
80	18434	26493	34916	44768	54303	65281	75334	86866	96943
90	22056	31666	41760	53245	64429	76915	88422	101179	112384
100	25143	36271	48024	61107	73905	87834	100718	114588	126783
PNBA = 120%									
30	813	1805	2711	4366	5756	8292	10238	13758	16265
40	3670	5996	8330	11867	15057	19827	23797	29740	34385
50	7633	11652	15770	21375	26594	33613	39711	47938	54706
60	12264	18125	24188	31898	39212	48404	56599	66917	75668
70	17147	24909	32982	42779	52180	63436	73631	86829	96364
80	21953	31627	41734	53576	65025	78229	90303	104176	116275
90	26419	37998	50143	63987	77439	92489	106323	121692	135151
100	30331	43797	57981	73795	89219	106039	121542	138269	152917



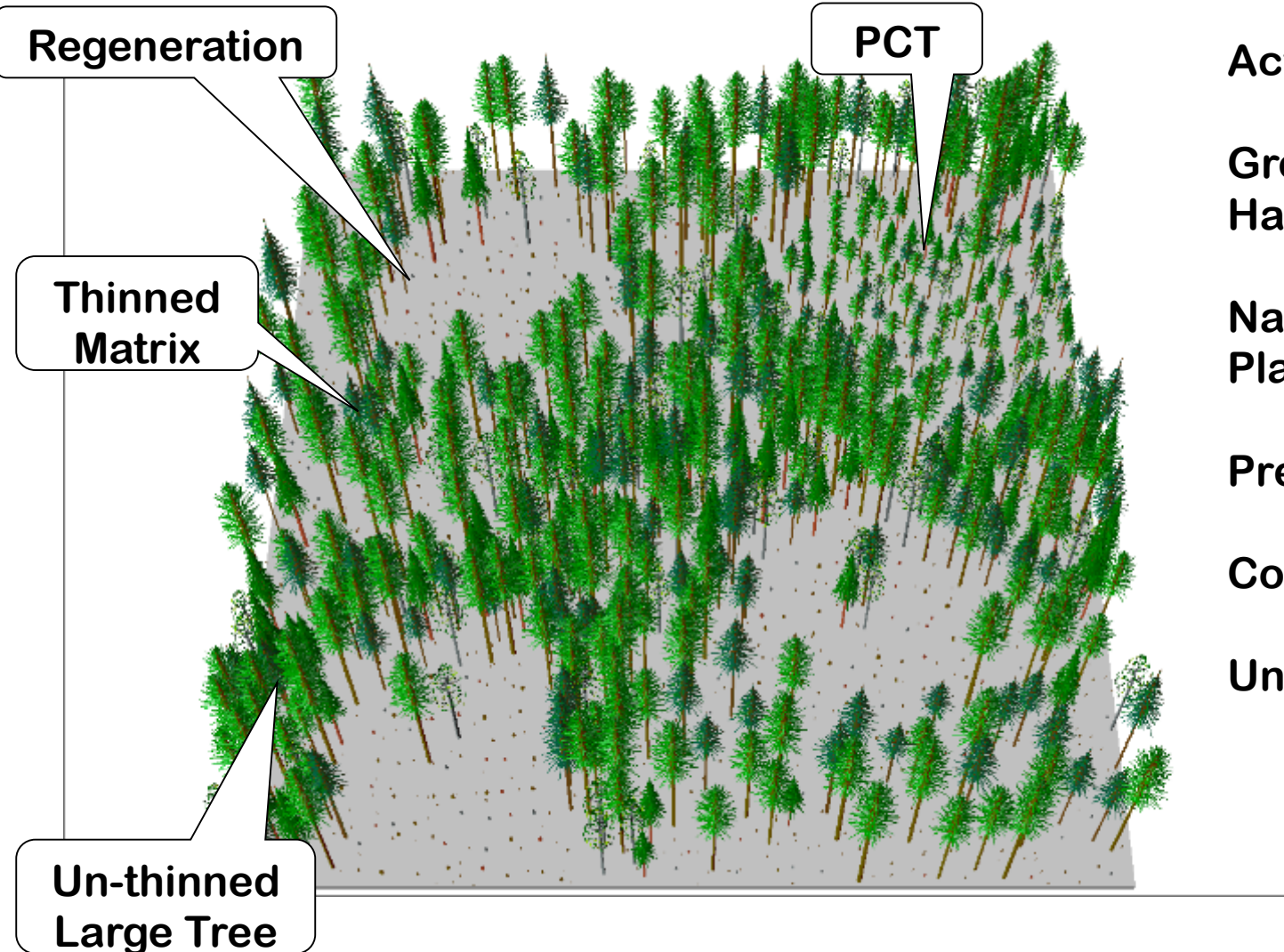
# Group Selection System

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# Group Selection System

## - Area Control Method of Uneven-aged Management



### Activities:

Group-Selection  
Harvest

Natural Regeneration  
Planting


Pre-comm. Thinning

Commercial Thinning

Understory Thinning

# Scheduling Group Selection Treatments

## Area Control Method

		Cutting Cycle					
		1	2	3	4	5	6
Stand Area							
20%		Group Selection	PCT	Commercial Thin	Commercial Thin	Group Selection	PCT
20%		Commercial Thin	Group Selection	PCT	Commercial Thin	Commercial Thin	Group Selection
20%		Commercial Thin	Commercial Thin	Group Selection	PCT	Commercial Thin	Commercial Thin
20%			Commercial Thin	Commercial Thin	Group Selection	PCT	Commercial Thin
20%				Commercial Thin	Commercial Thin	Group Selection	PCT
							
		40	60	80	100	120	140
		Stand Age					



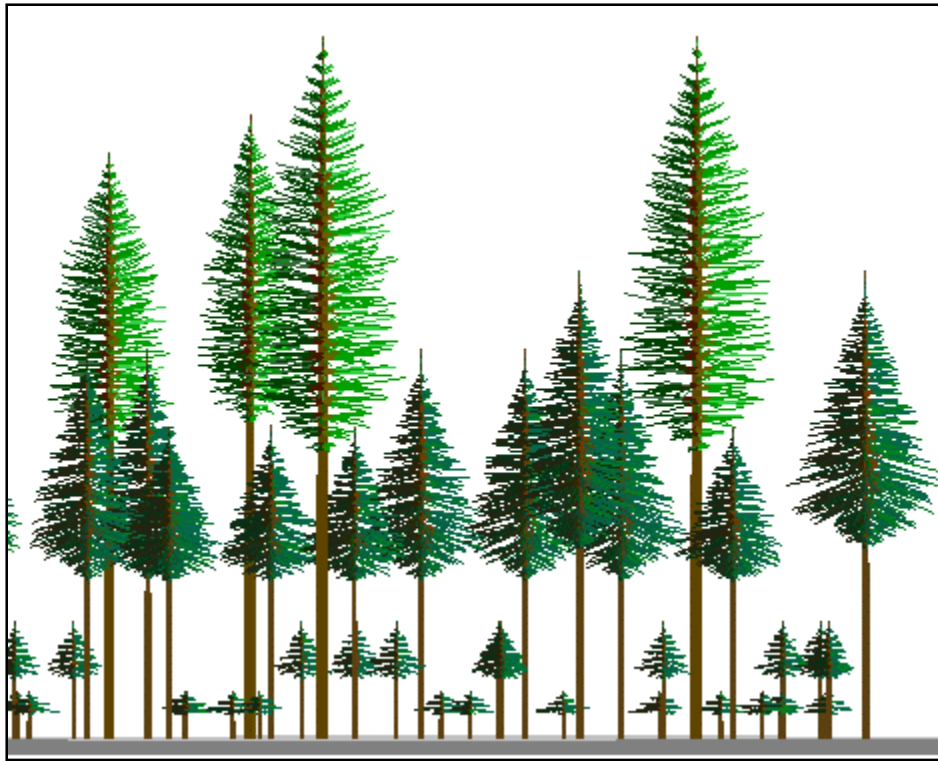
# Group Selection System –Prescription Matrix

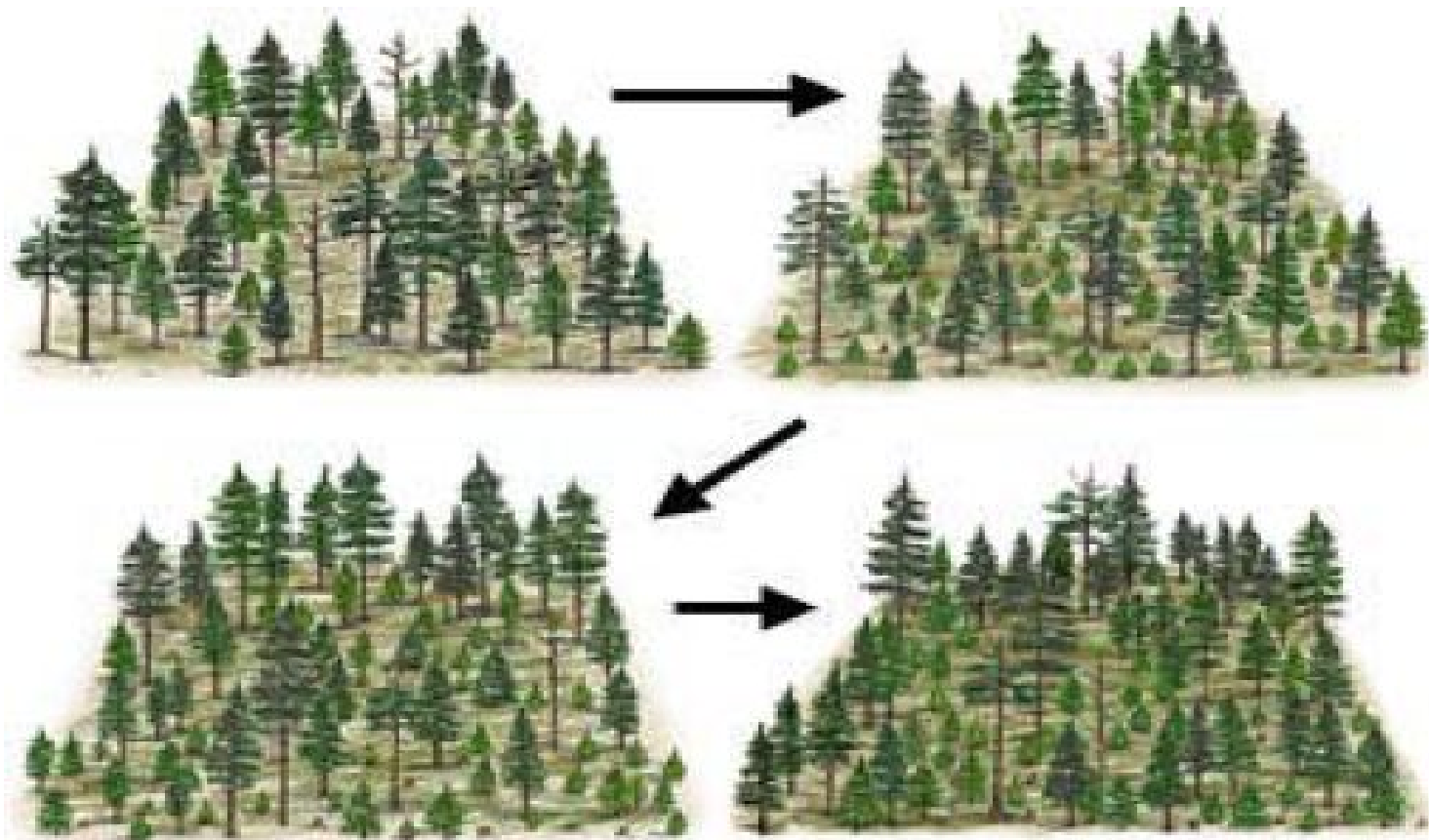
## Uneven-aged Group Selection Management Regime

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<b>Activity</b>		<b>Conditions</b>	<b>Prescription (SI 110)</b>
<b>Regeneration</b>		at cutting cycle	20% in 1-2 ac gaps, min age 35 yrs, Cutting Cycle 20 yrs
<b>Reforestation</b>		at year 1 where cover <40%	nat.regen WH 200 DF, 50 RA, 100 RC,
<b>Density Management</b>	Pre-commercial Thinning	top height 15 ft. or age >15 yrs	Thin to 250 TPA
	Commercial Thinning	at 55% of max SDI (or BA > 260 sqft)	160 TPA thin from below or 30% CF volume, possible 2nd CT remove 20% of CFvol
	Understory Thinning	at 2nd CT, after CT where WH understory established	if understory h/d<100 Thin to 150 TPA,
<b>Habitat Enhancement</b>	Riparian Management Zone	applies to CT and group selection	retain 20 TPA >12"DBH or retain 20-40% cover in RMZ, underplant 100 RC/ac
	Dead wood		retain 2 TPA as snags and 2 TPA as down wood at Regeneration

# Single Tree Selection



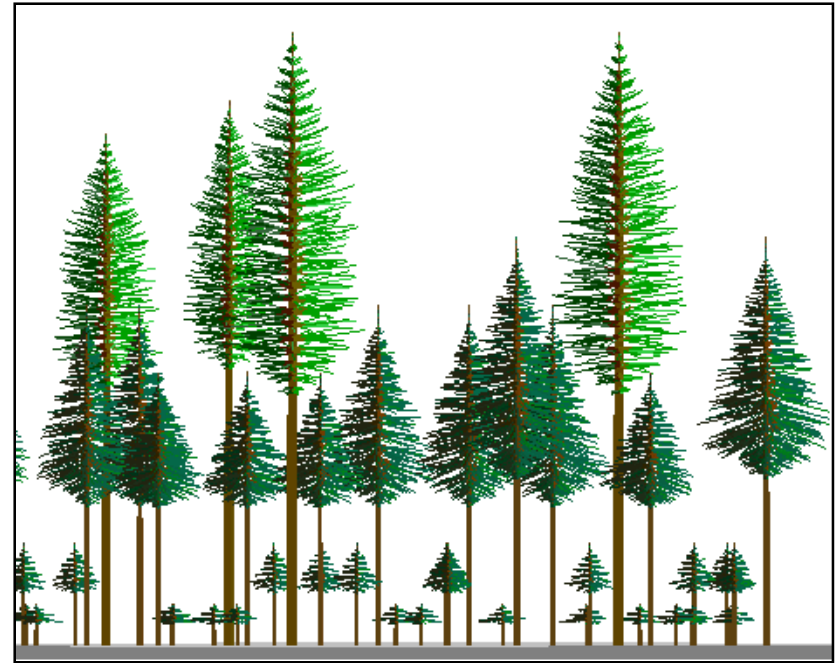
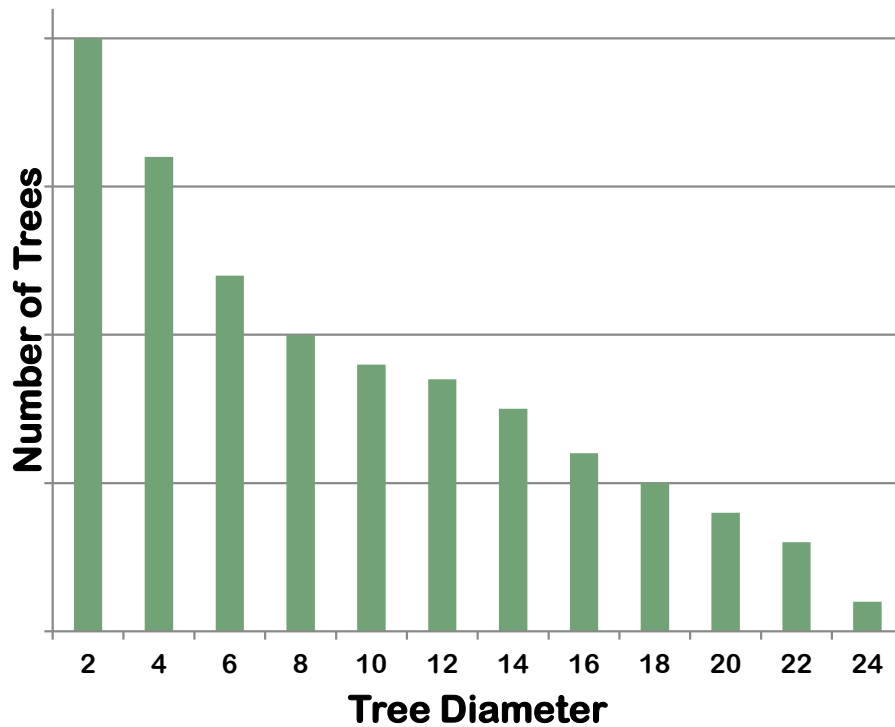




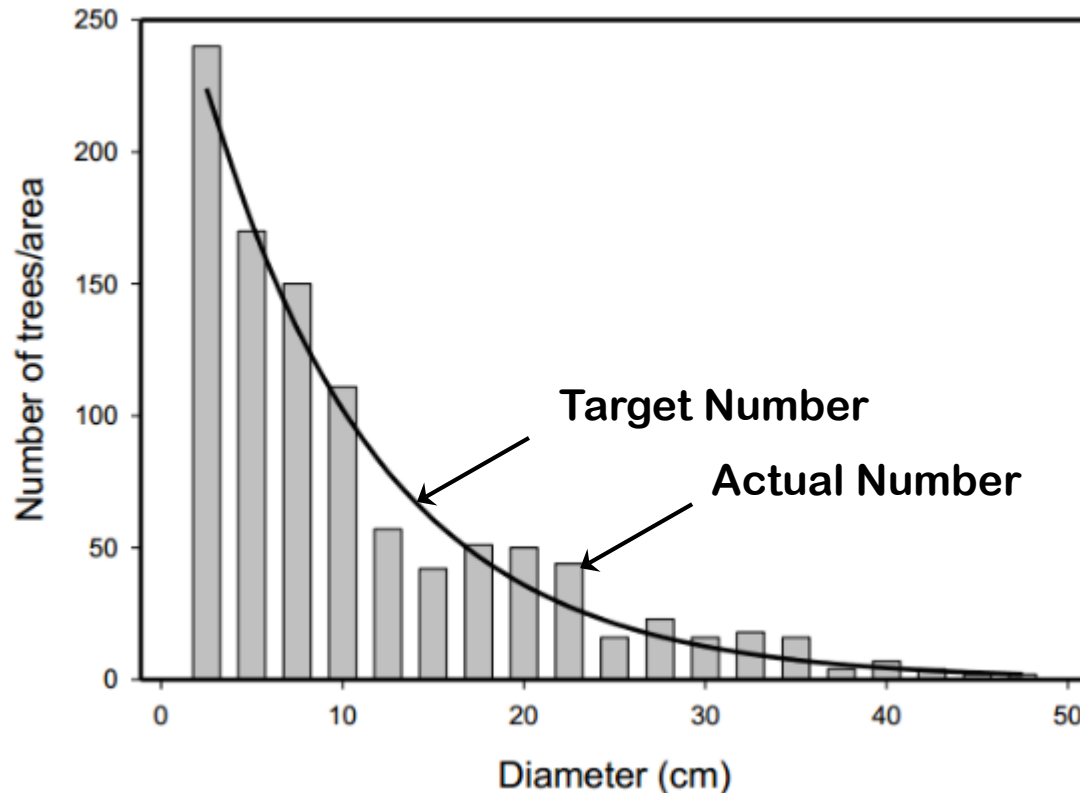
# Single Tree Selection

– developing a guide curve from tree count and diameter

Tree Tally by 2 inch Diameter Class



# Single Tree Selection



**Guide Curve:**  
Total basal area  
Maximum Diameter  
“slope”

**At each cutting cycle  
we thin trees in classes  
that exceed the guide  
curve.**

# Uneven-aged Management Forest Products – Marketing Product Diversity

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# Assessing growth and control density of all tree sizes and species in the same stand

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# Assessment of Growth – Overstory diameter increment

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Annual growth ring



# Assessment of Growth – Mid-canopy trees

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- Crown ratio
- Height-diameter ratio





# Assessment of Growth – Understory trees

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Growth of terminal shoot versus lateral branches -  
Douglas-fir



Large Gap >30% Light



Small Gap ~20% Light



Under Canopy >20% Light

# Tools For Assessment – Diameter Distribution

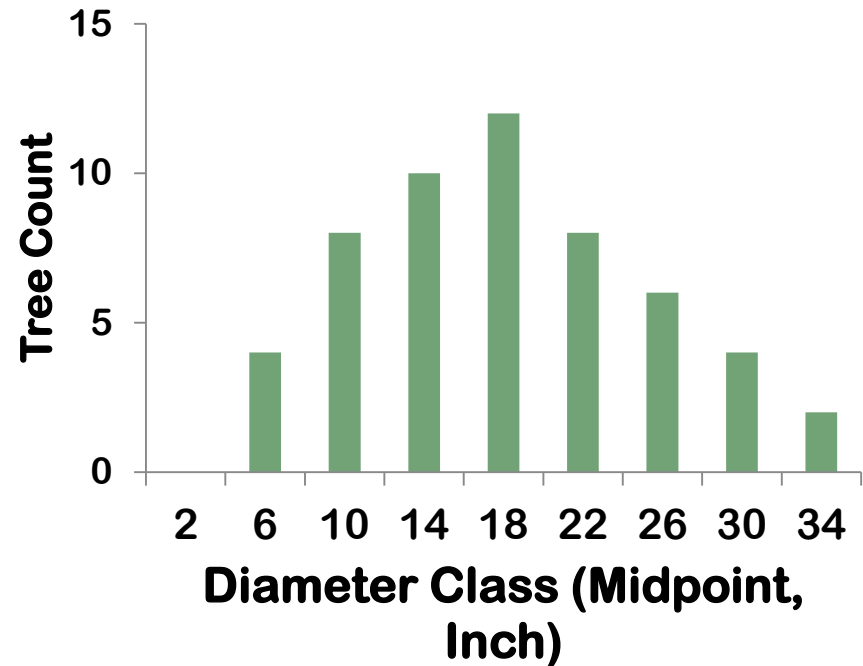
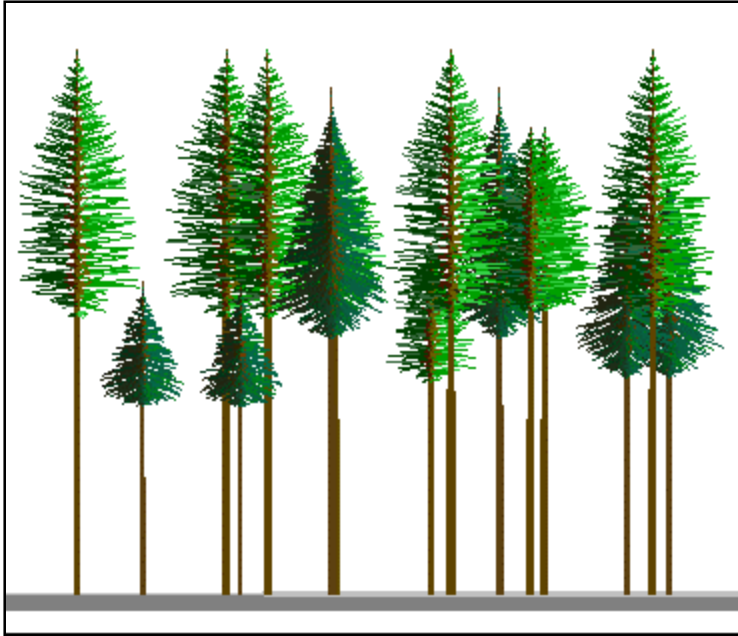
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Tree Diameter Tally Sheet				
DBH Class (Inches)	Plot 1 Count	Plot 2 Count	Plot 3 Count	Sum Tree Count
0-4	0	0	0	0
4-8	2	1	1	4
8-12	4	1	3	8
12-16	6	2	2	10
16-20	2	2	8	12
20-24		6	2	8
24-28		1	5	6
28-32	4			4
32-36	1	1		2



# Tools For Assessment – Diameter Distribution of Even-aged Stand

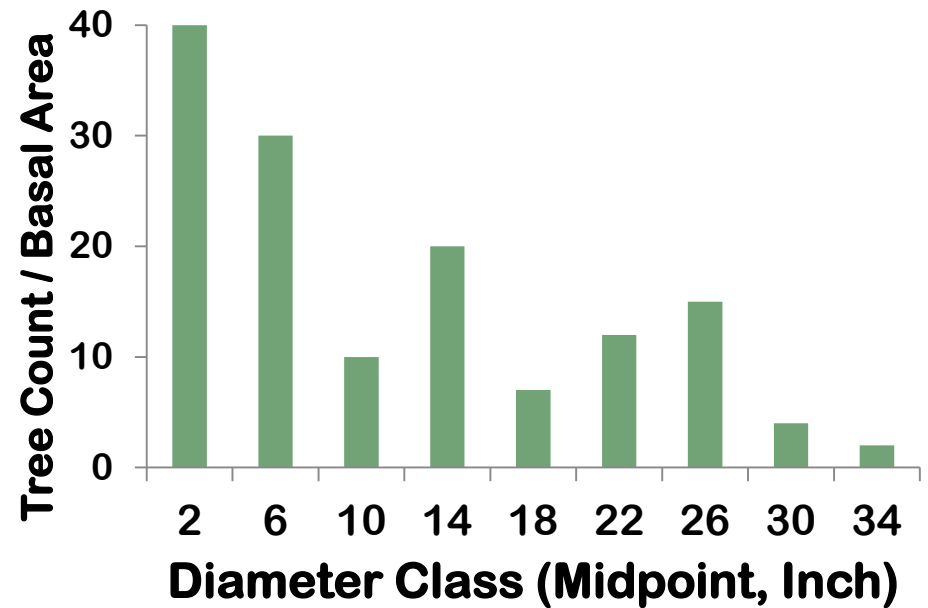
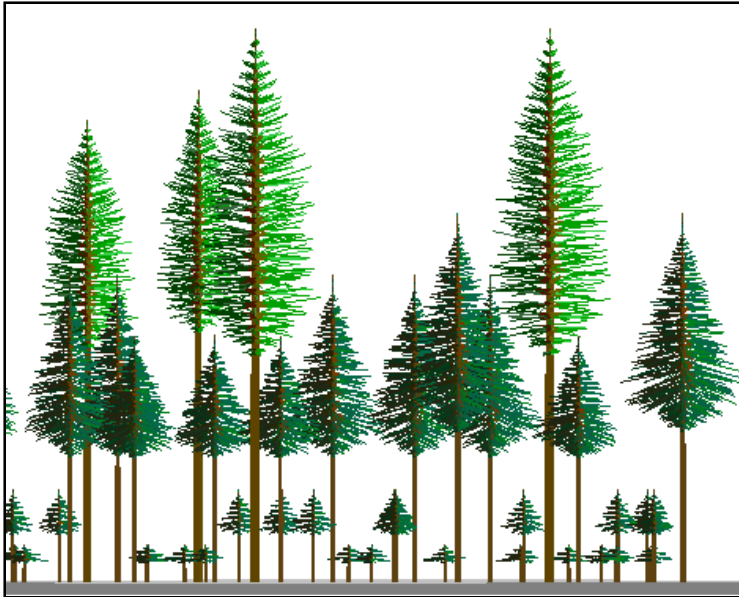
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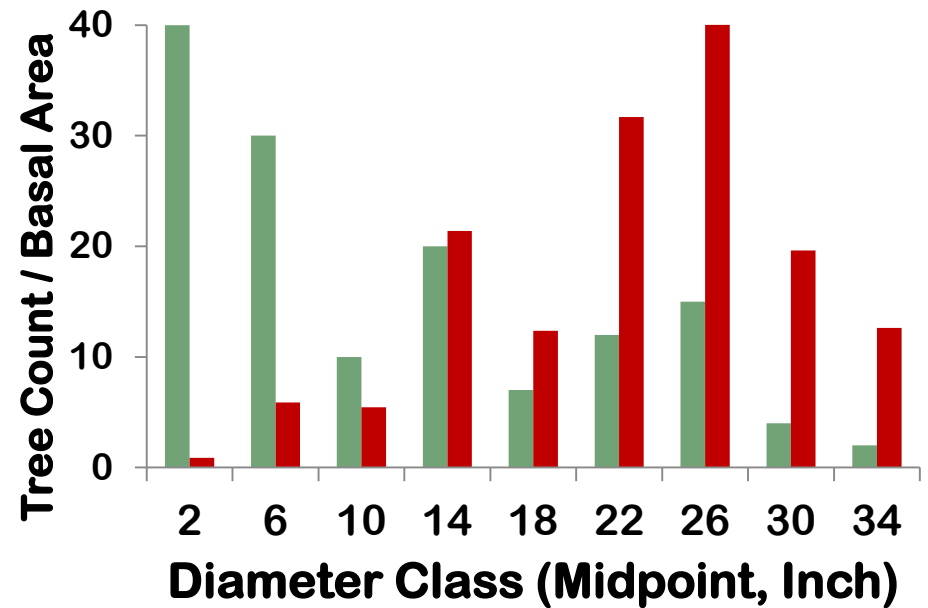
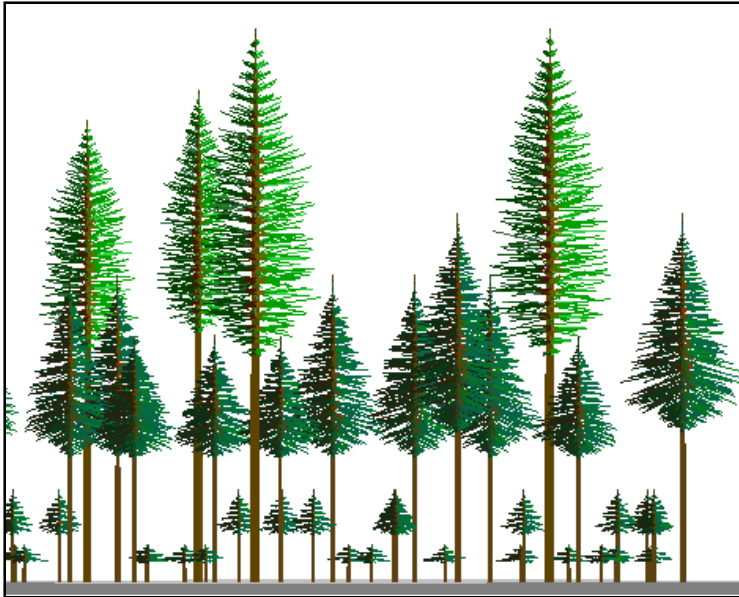
# Growing Space Distribution – Diameter Distribution of Multi-aged Stand

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# Growing Space Distribution – Basal Area of Diameter Classes

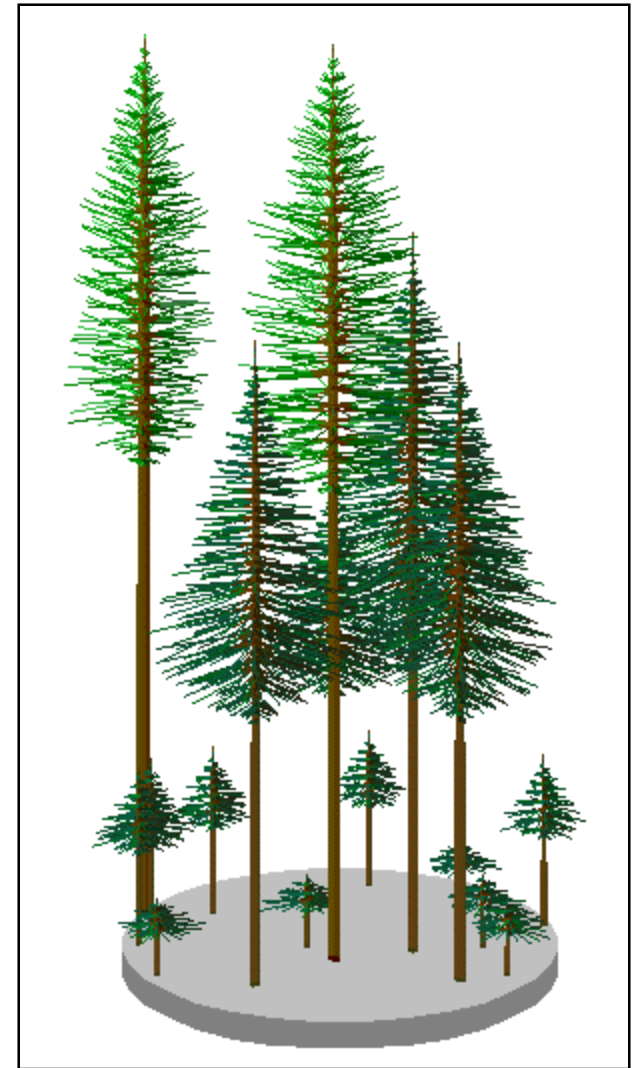
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# Permanent Sample Plots

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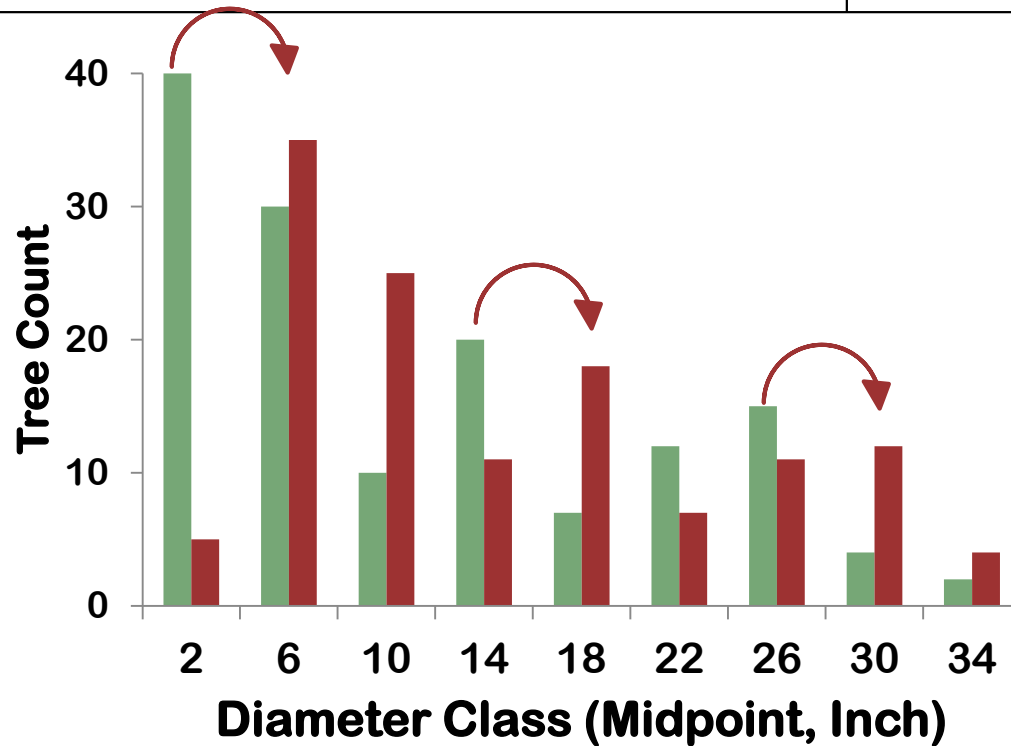
- ❑ Species composition
- ❑ Size classes
- ❑ Stand volume
- ❑ Diameter growth
- ❑ Height growth
- ❑ Mortality
- ❑ Harvest





# Permanent Sample Plots – Diameter distribution and increment

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Inventory Period 1:  
Diameter distribution

Inventory Period 2:  
Diameter distribution  
Diameter class transition

# Thinning and Harvest

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- **Objectives**

- Stocking Control, Regeneration, and Timber

- **Timing**

- Recovered previous harvest, market conditions, boat payments

- **Make a plan**

- Long-term plan as Guide not Rule

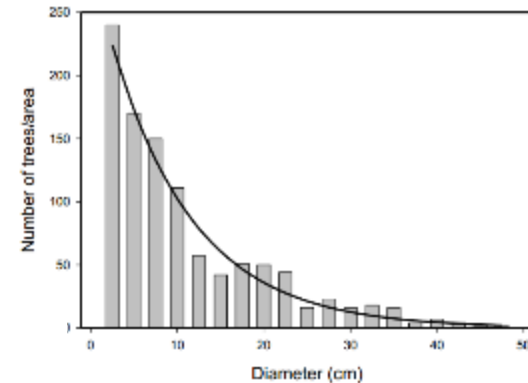
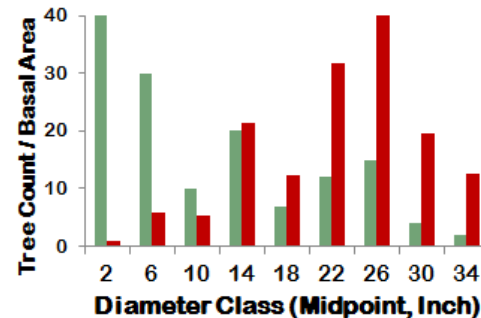
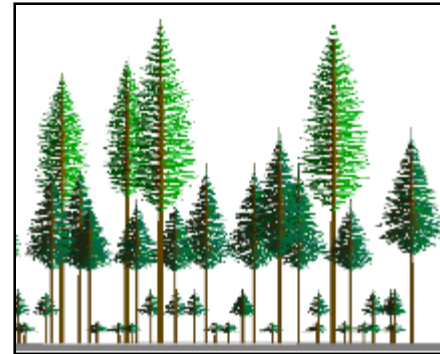
- **Creating habitat**

- CWD, snags, canopy layers

# Tree Selection and Marking

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- Creating growing space
- Selection guide
- Basal area
- Diameter distribution
- Mark your Trees



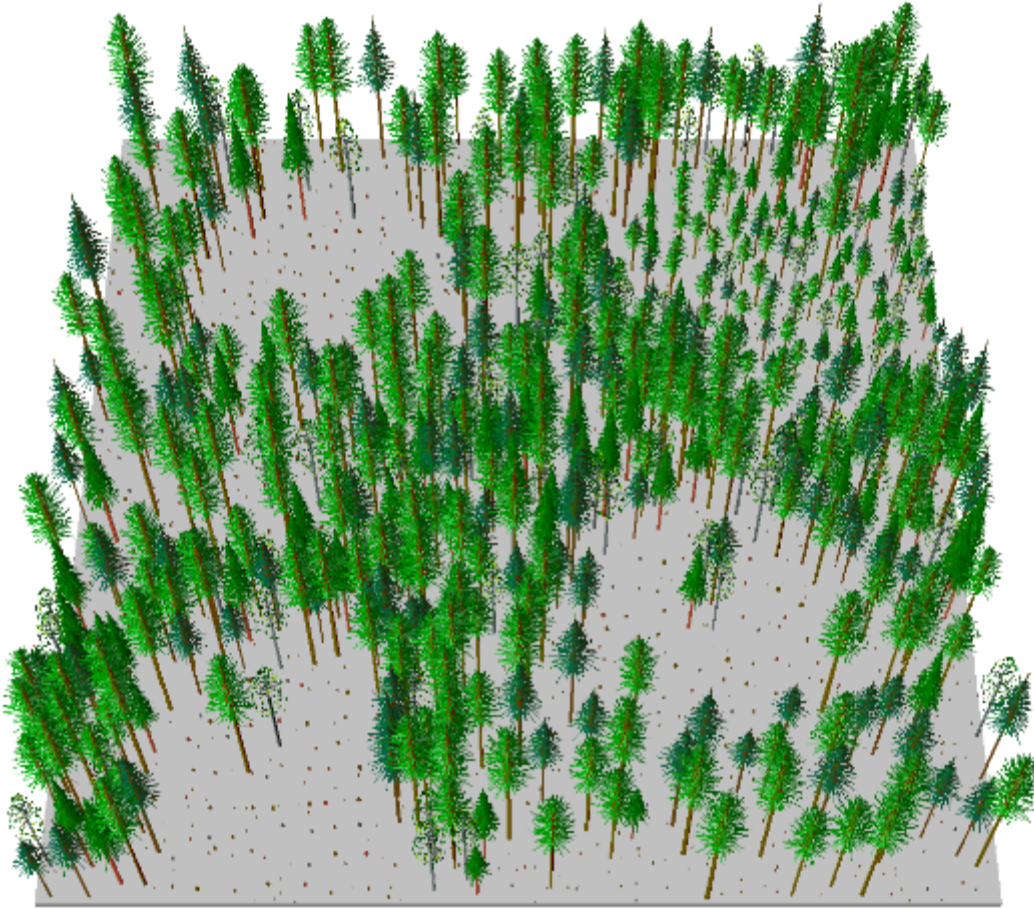


# Harvest Layout

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- **Units and boundaries**
  - Uneven-aged stands are more variable
- **Forest Practices**
- **Roads and trails**
  - Long-term planning and reuse
- **Collaboration**

# Group Selection System – Planning operations



- Layout for thinning and group selection harvest
- Location for yarding corridors
- Tracking regeneration
- Prescriptions for matrix thinning
- Estimating stocking and ingrowth

# Implementation

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# Harvest Impacts

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