



Forest Development Stand Dynamics

August 10, 2004







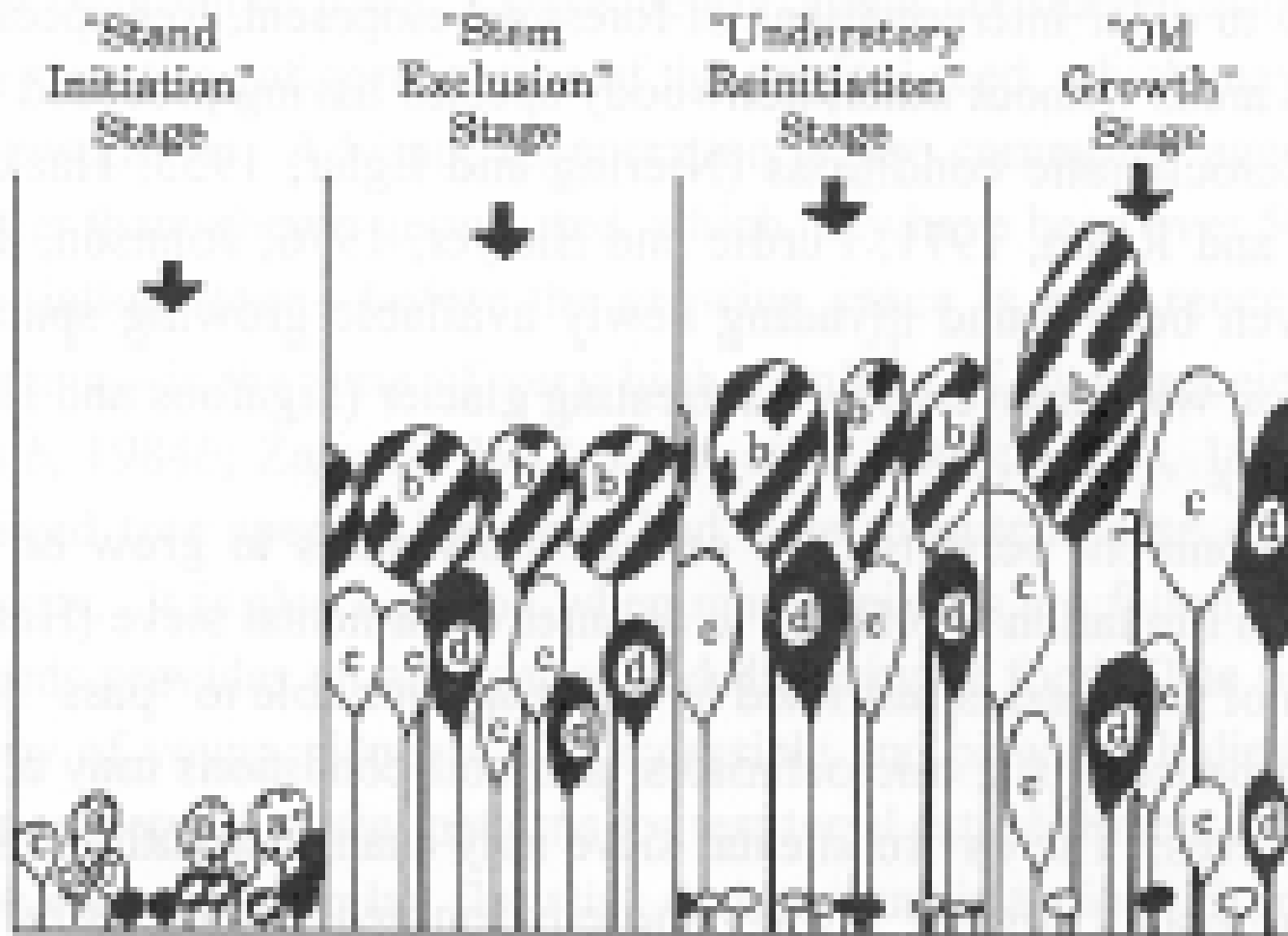


Stand Dynamics Model

(Oliver and Larson)

- **Stand Initiation:** New individuals appear until the available growing space is fully utilized
- **Stem Exclusion:** Trees compete with each other for resources. No new individuals establish. In mixed species stands dominance may shift among species.
- **Understory Reinitiation:** The stand begins to lose its grip on the site. Death of large trees provides gaps that cannot be completely filled by existing vegetation. New individuals establish.
- **Old Growth:** Overstory trees die and understory trees take their place.

Oliver and Larson Model



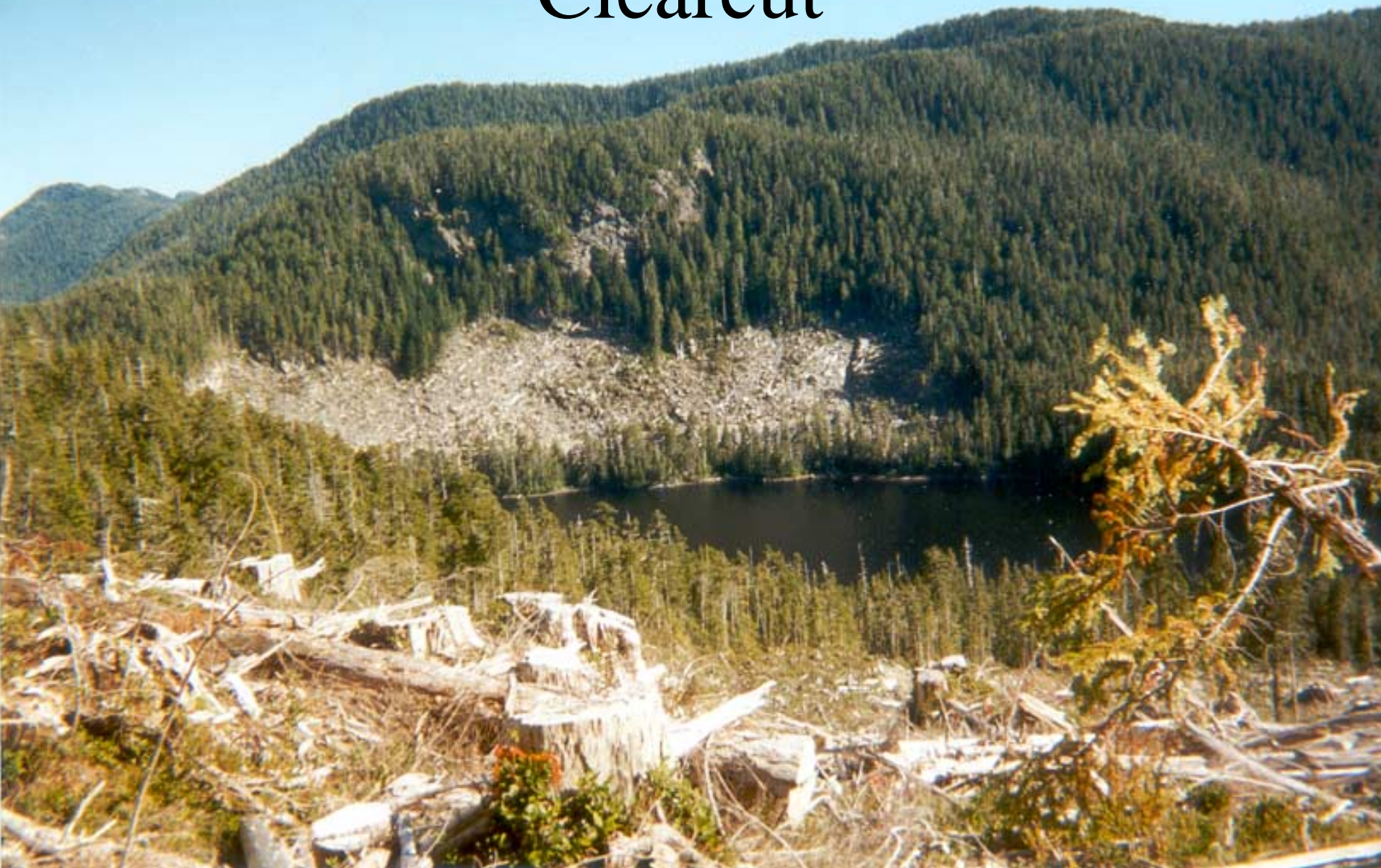




Shelterwood



Clearcut





Stem Initiation



Stem Initiation

- **The age range of the new stand depends on the length of time it takes for trees to invade and establish.**
- **Age distributions in stands result from disturbance frequency and magnitude. A single-cohort stand is only one of many possible outcomes.**
- **Trees invade until all growing space is occupied.**

Stem Initiation

- **Once a tree is established it grows upward, outward, and downward,
– it's rate of expansion varying by species, site, and competition.**
- **The more it grows, the better the tree can withstand changes in its environment AND keep competitors shaded, shorter, and less competitive.**







Stem Exclusion

Density DEPENDENT Regulation

- All species compete for the same set of resources: light, moisture, nutrients, O_2 , CO_2 .
- Species differ greatly in ability to tolerate low level of resources
- Differences in tree architecture arise from differences in photosynthate allocation.
- These architectural differences may confer competitive advantages under different environmental conditions.

Stem Exclusion

- **During the stem exclusion phase, the initiating cohort fully occupies site growing space.**
- **If seedlings germinate, they soon are outcompeted by the initiating cohort.**
- **In some instances, a very shade-tolerant**
- **Understory develops but does not grow very much.**
- **Microsite differences may help one individual to grow better than surrounding individuals, including from the same species – i.e. outcompete**

Example of Tolerance - Shade

Table 1. Shade Tolerance of Commercially Important Conifers in Washington

Extremely Tolerant	Tolerant	Intermediate Tolerance	Intolerant	Extremely Intolerant
Western Hemlock Western Redcedar Pacific Silver Fir Alaska Yellow Cedar Mountain Hemlock	Grand Fir Subalpine Fir Engelmann Spruce	Inland Douglas-fir Western White Pine	Coastal Douglas-fir Noble Fir Ponderosa Pine Sitka Spruce	Lodgepole Pine Western Larch

From: Forest Ecology in WA – Hanley & Baumgartner

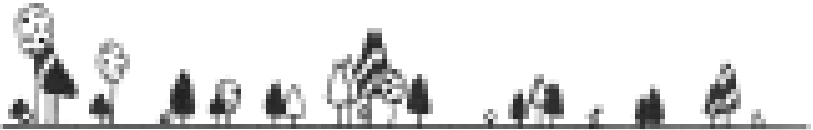
Coastal Douglas-fir Forests

- **Douglas-fir overtops western hemlock in 2-3 decades, even though hemlock seedlings are more numerous.**
- **When not competing directly with Douglas-fir, hemlock is able to grow into the overstory.**
- **At higher elevations, western hemlock competes more strongly and both species are found together in the overstory.**
- **Adding red alder complicates development of Douglas-fir / hemlock stands. Spatial patterning and slight age differences determine if Douglas-fir or red alder have a competitive advantage.**
- **Neither can survive beneath the shade of the other.**

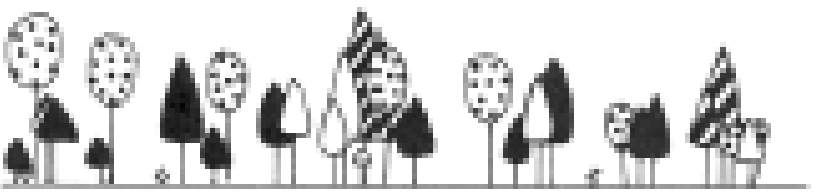
1931



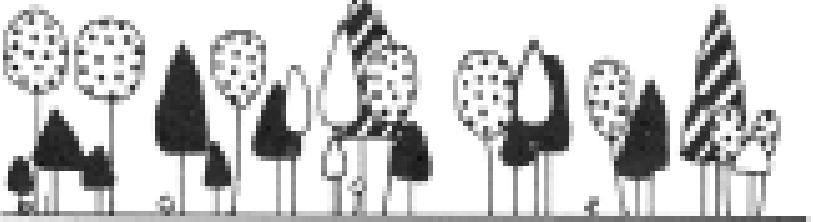
1941



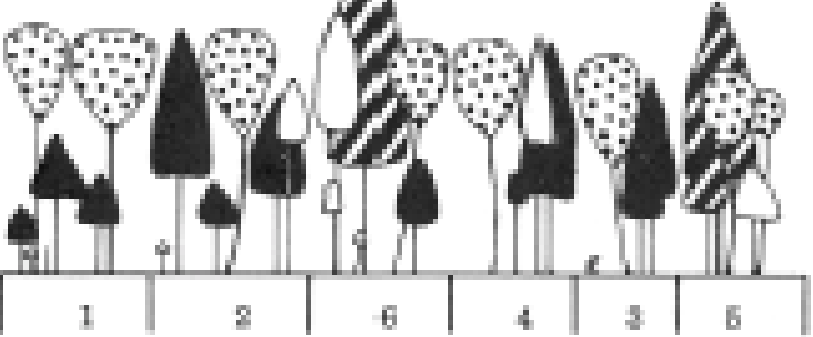
1951



1961



1976



PLOT NUMBER

**Douglas-fir (diagonal bars),
red alder (dotted),
Western redcedar (black),
Western hemlock (white)**

Understory Reinitiation Density INDEPENDENT Regulation



Understory Reinitiation

Density INDEPENDENT Regulation

- **This phase is likely the least understood in terms of mechanisms and processes.**
- **The initiating cohort begins to break up, allowing new cohorts to establish and grow.**
- **Processes by which this occurs are somewhat unique to each stand.**

Understory Reinitiation

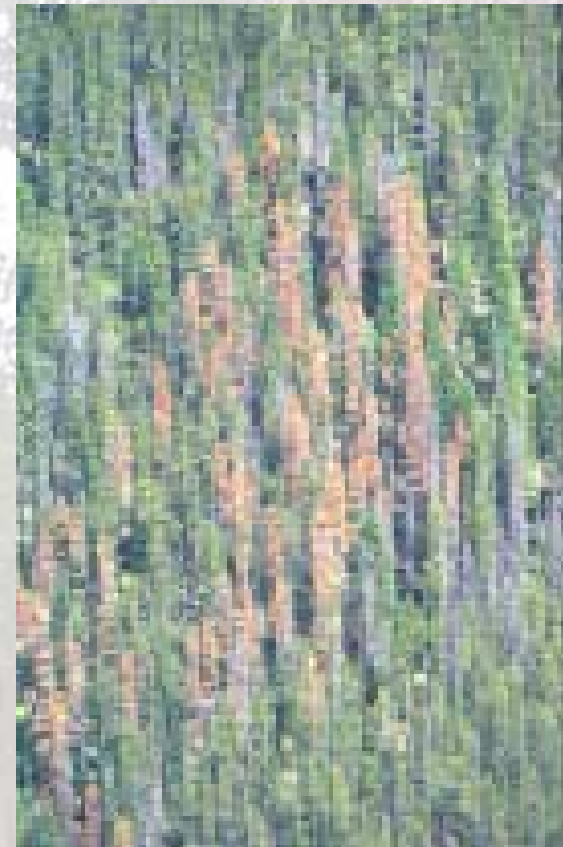
Density INDEPENDENT Regulation

- **Inability of the initiating cohort to continue to fully occupy site growing space.**
- **This occurs because of:**
 - **changes within trees**
 - **changes within the site**
 - **interactions between**
 - **the trees and the site**
 - **outside forces**
- **Then, new seedlings OR advanced regeneration can GROW.**

Understory Reinitiation

Density INDEPENDENT Regulation

- **Gap Dynamics – clumped mortality**
 - The term **GAP DYNAMICS** is most often associated with old growth forests,
 - but gaps in the fabric of forest canopies - young or old, small or large – create opportunities for the establishment of new cohorts.



Structural Diversity

- **Pit and mound topography**
- **Decadent trees**
- **Sub-lethal damage creates structure in**
- **living trees:**
 - **broken tops**
 - **dead tops**
 - **multiple tops**
 - **brooming**

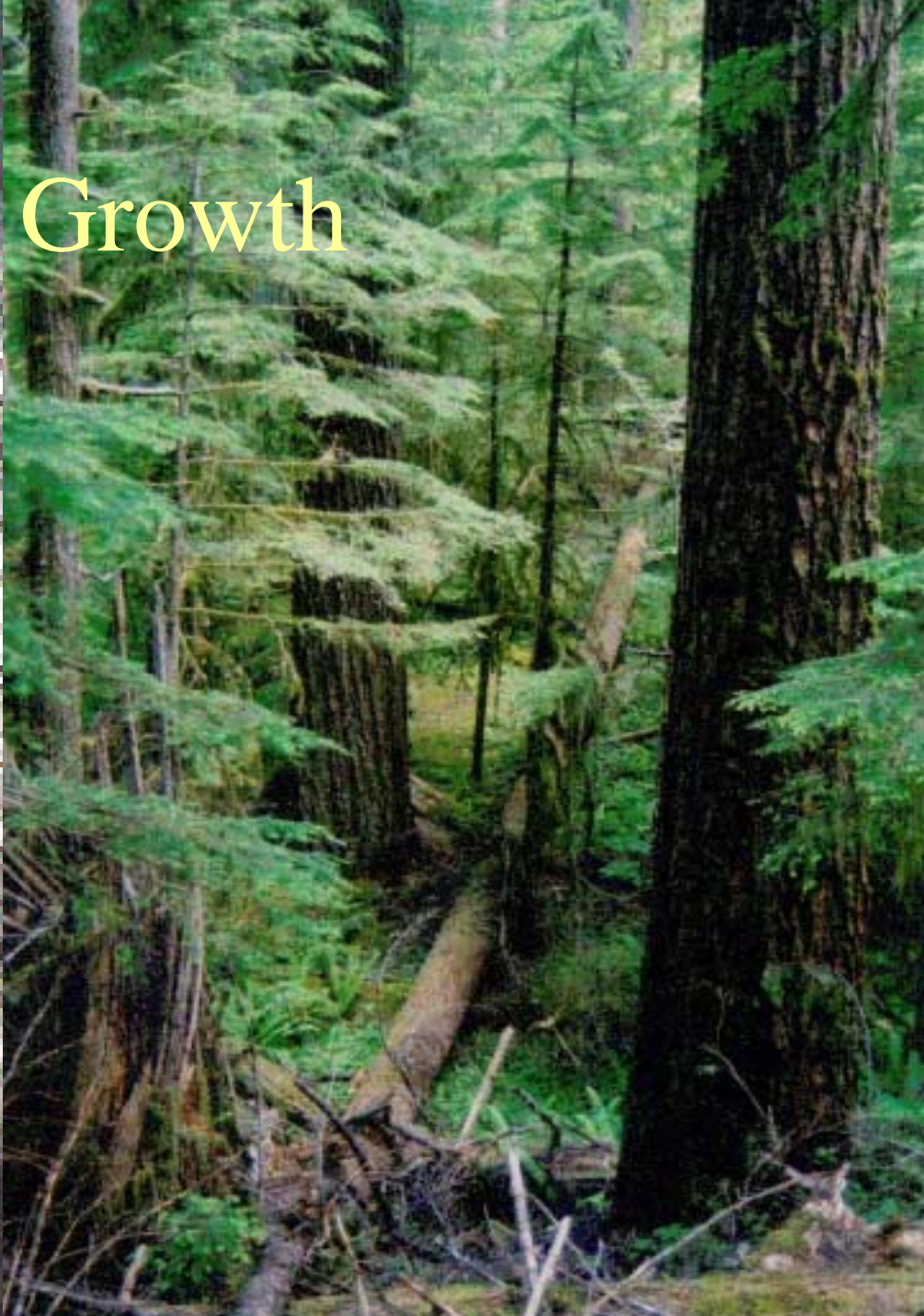




Old Growth



Old Growth



Old Growth

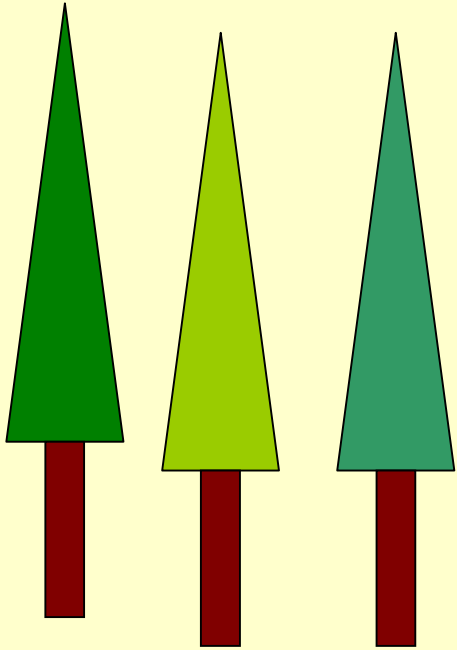
- **Overstory replacement by younger cohorts.**
- **The PROCESS of old growth development is a continuation of the process of understory re-initiation.**
 - **Gap dynamics**
- **The STRUCTURAL approach to Old Growth emphasizes large living AND dead trees (large is relative to productivity and size of trees, etc).**

Old Growth

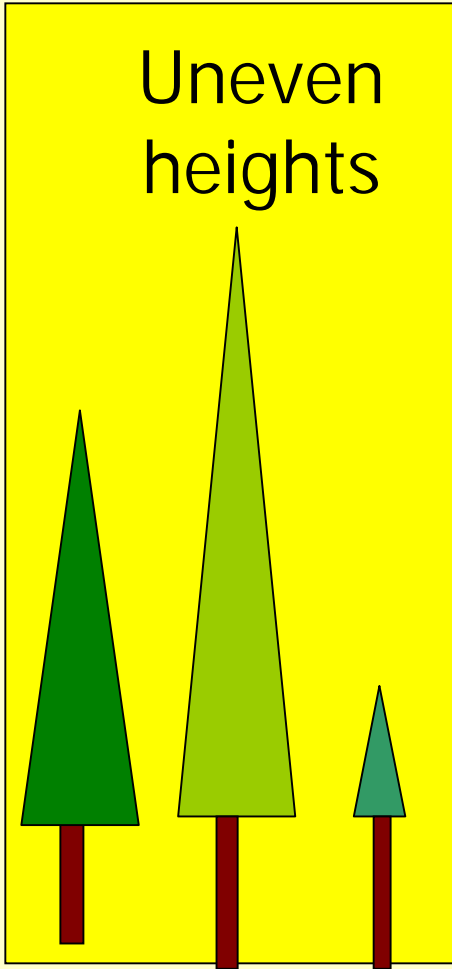
- **Where does the Understory Re-initiation phase end and the Old Growth phase begin?**
- **From a purely process point of view, UR ends with the death of the last tree of the initiating cohort. some **application****
- **But this has some faults b/c:**
 - 1) **tree longevity – PSME stands would never be OG**
 - 2) **relict trees - legacies**
 - 3) **dismisses OG as a seldom achieved rarity**

Vertical Diversity

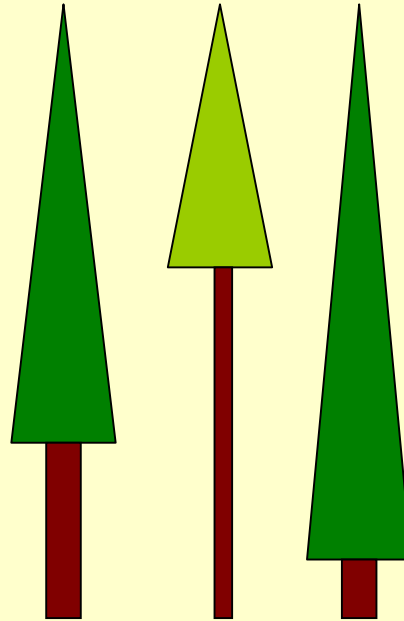
Even



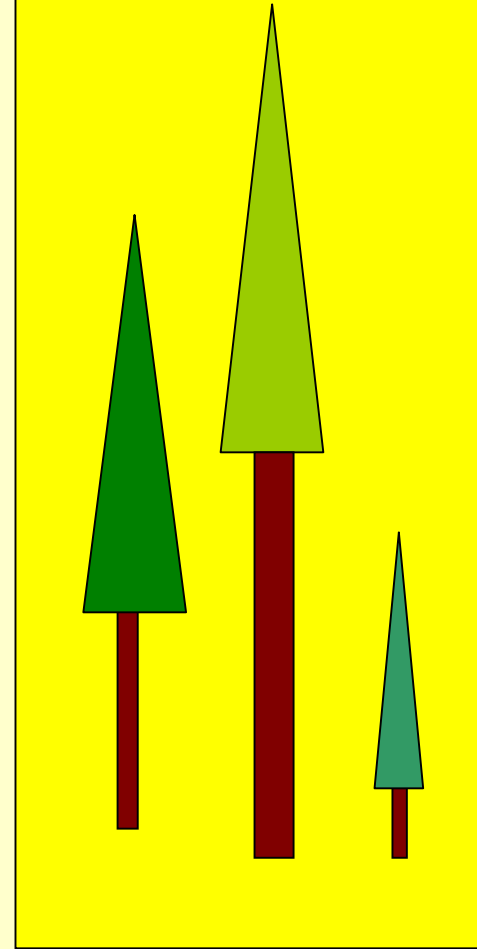
Uneven heights



Uneven crown-bases

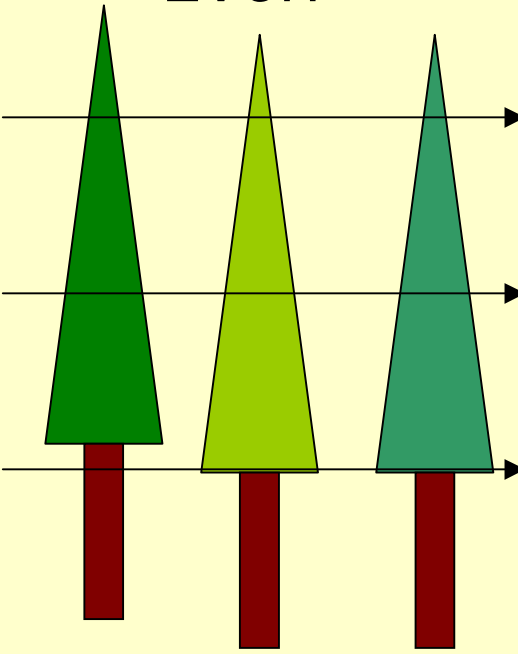


Uneven hts + crown-bases

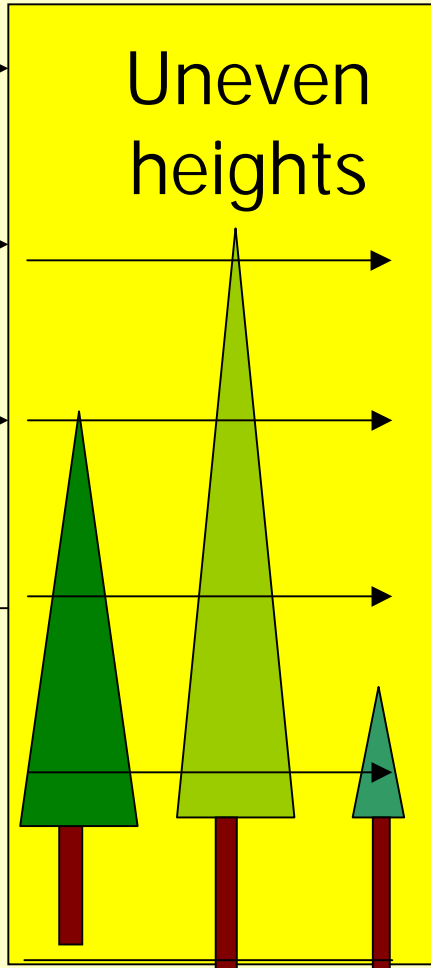


Vertical Diversity

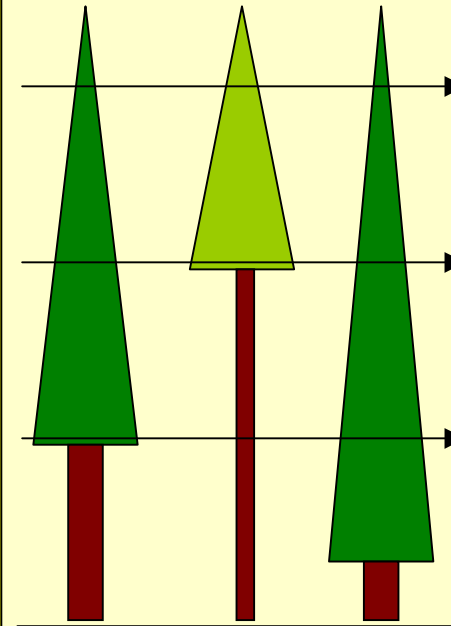
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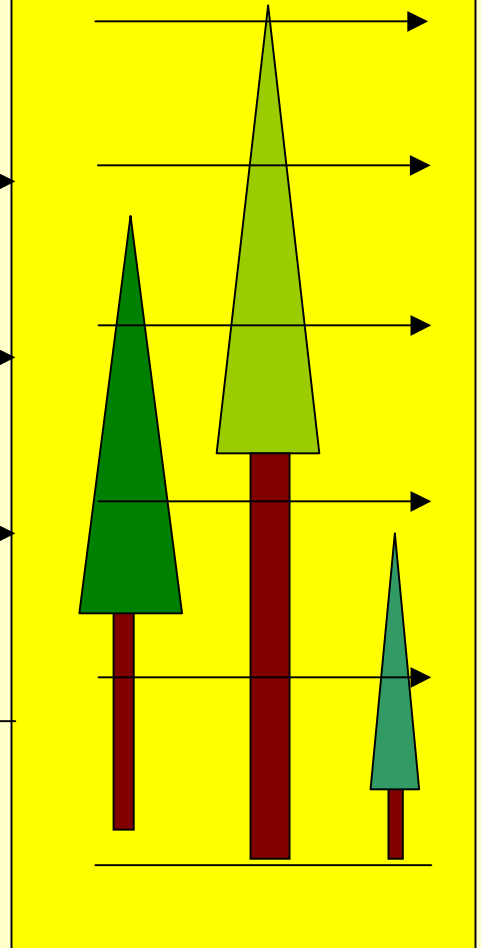
Uneven heights



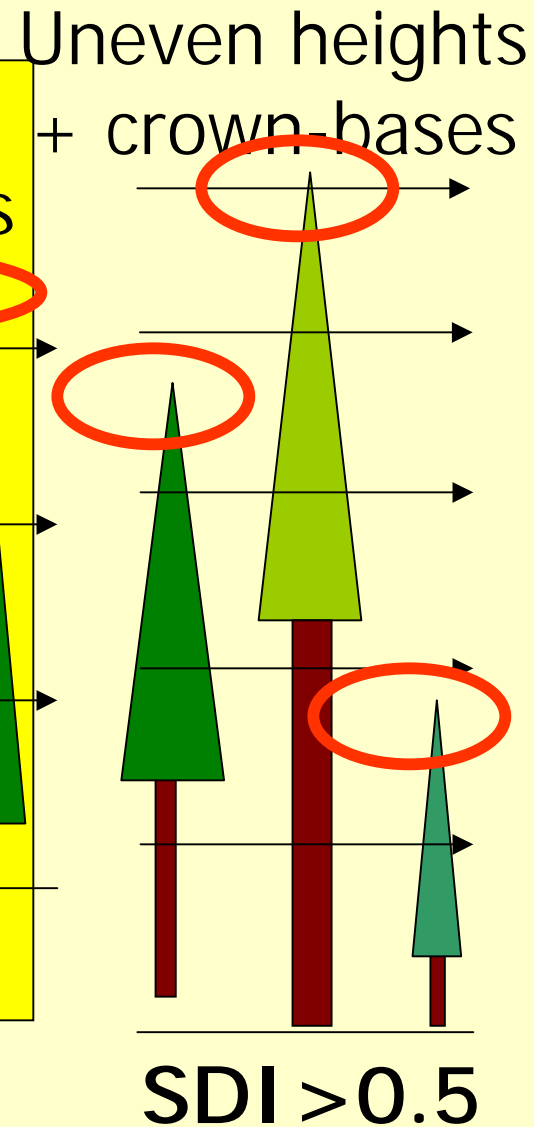
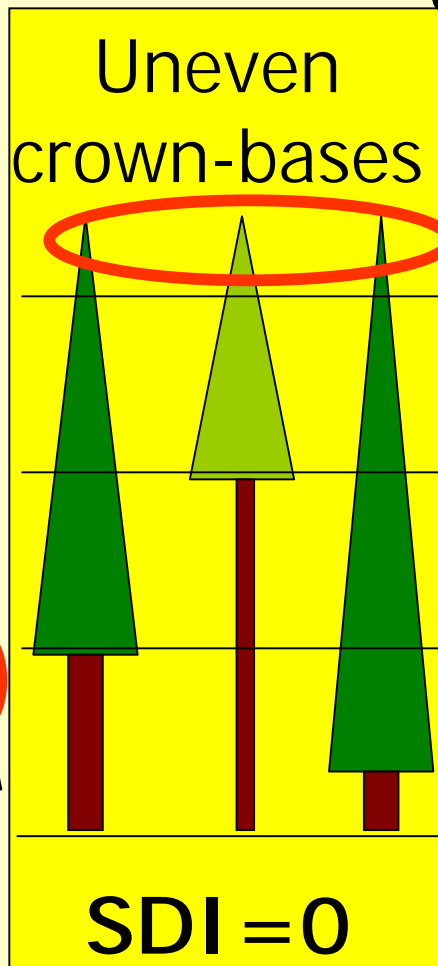
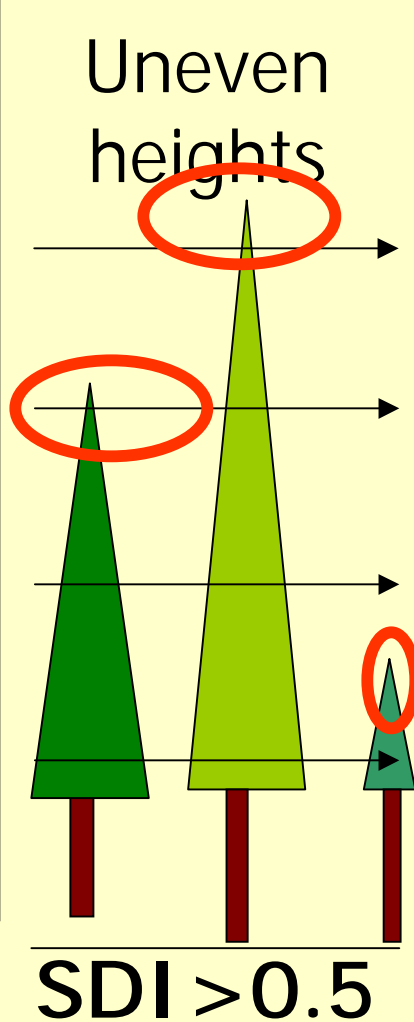
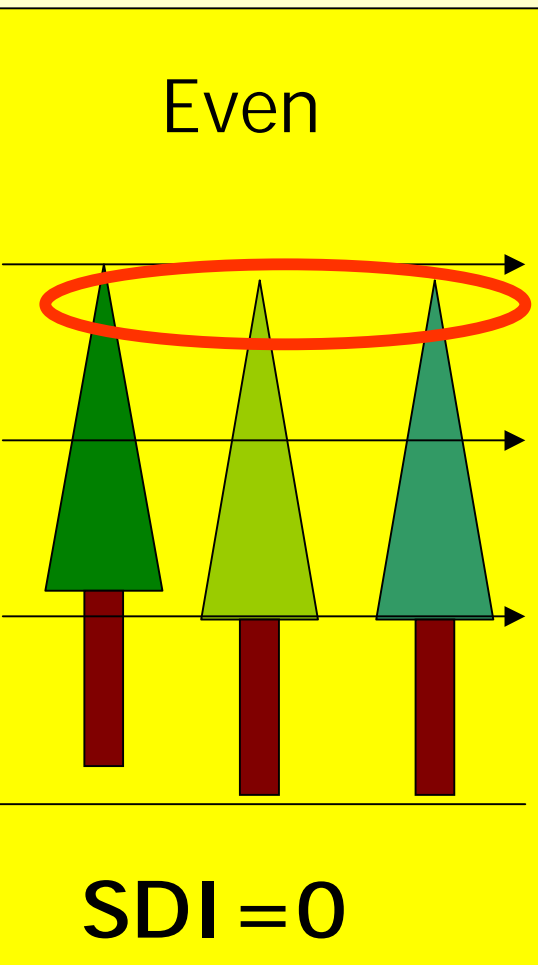
Uneven crown-bases



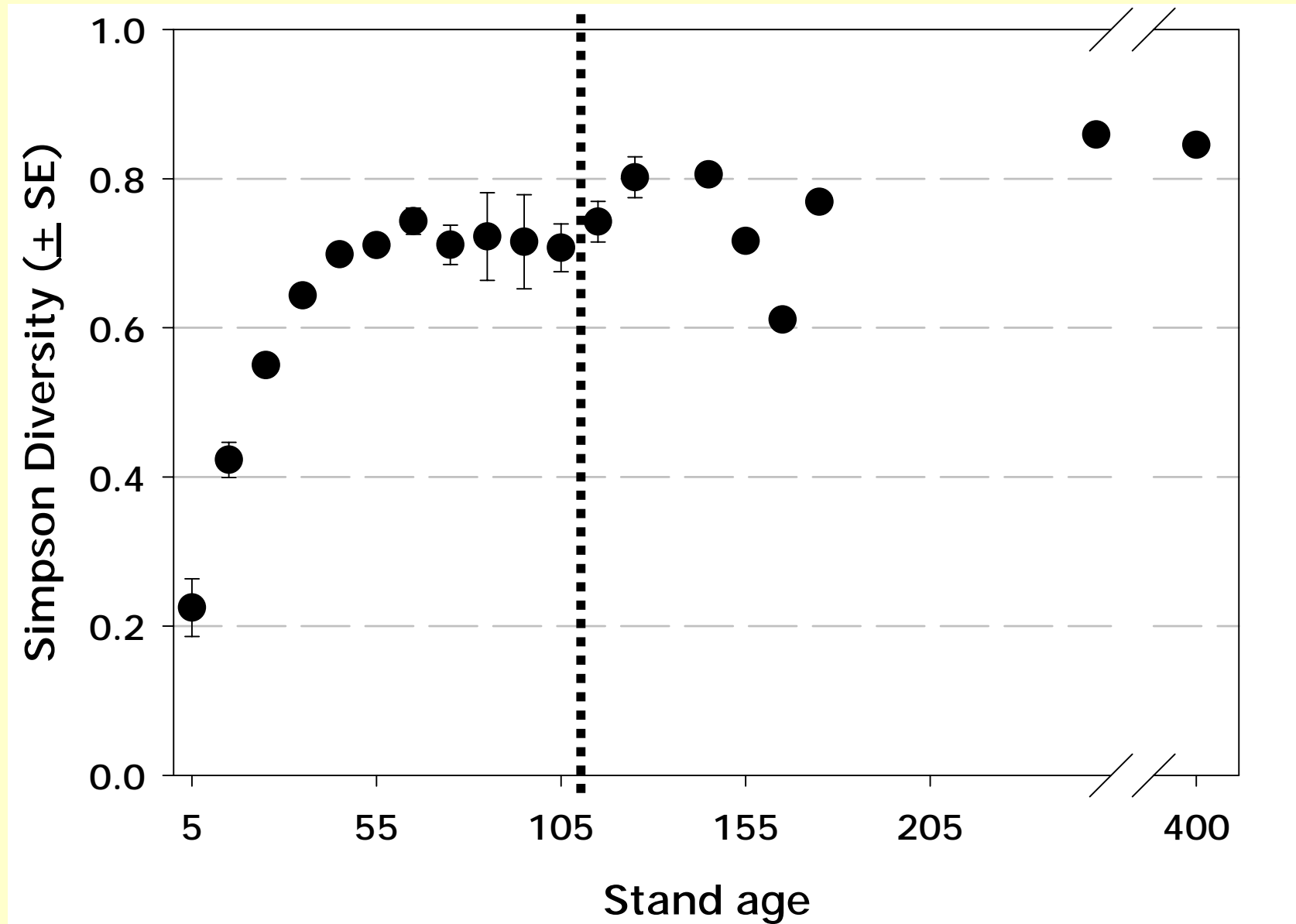
Uneven hts + crown-bases



Simpson's Index of Diversity of Tree Heights (SDI)



Simpson's Diversity of Heights

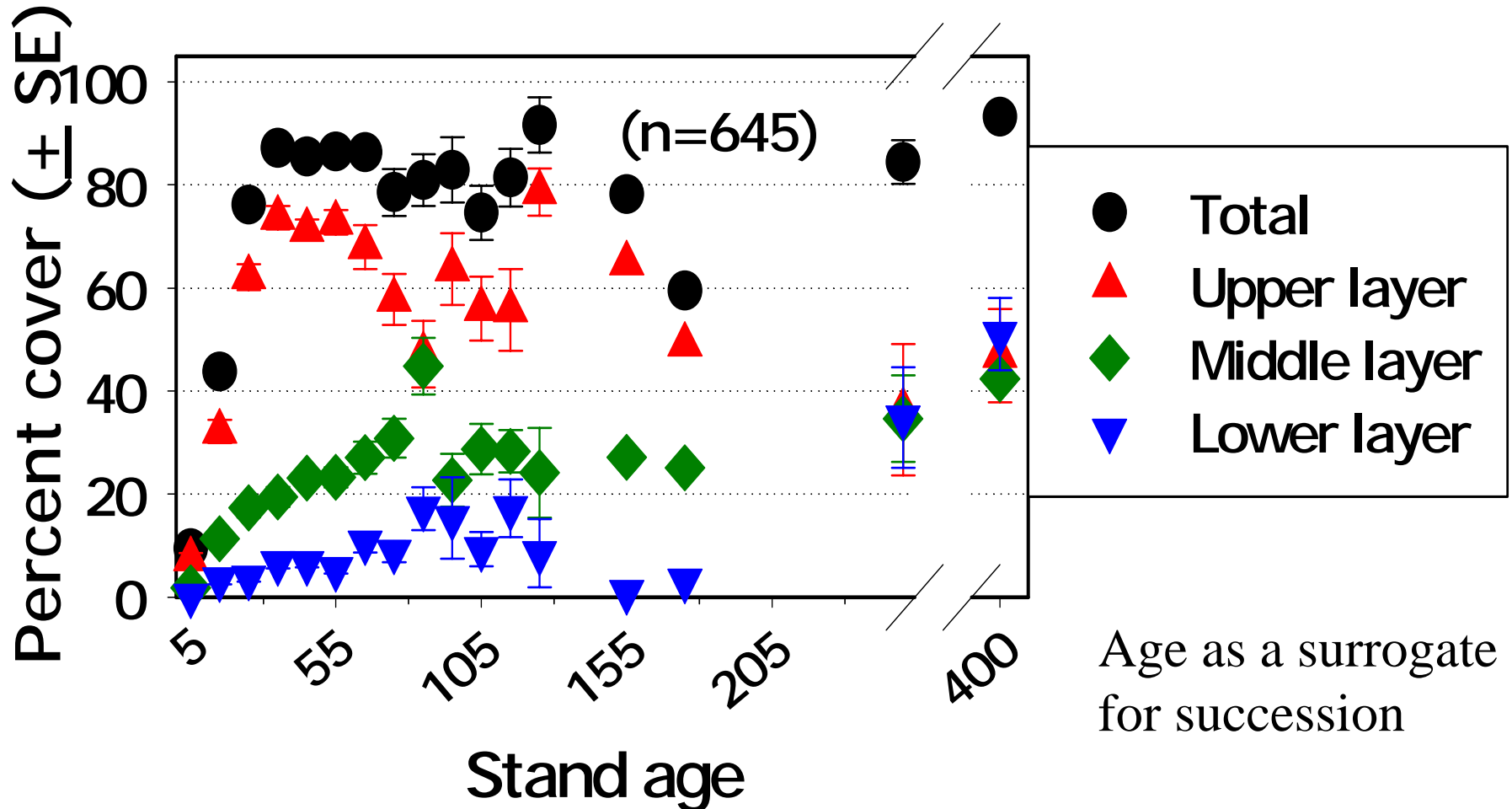


Multiple Definitions of OG

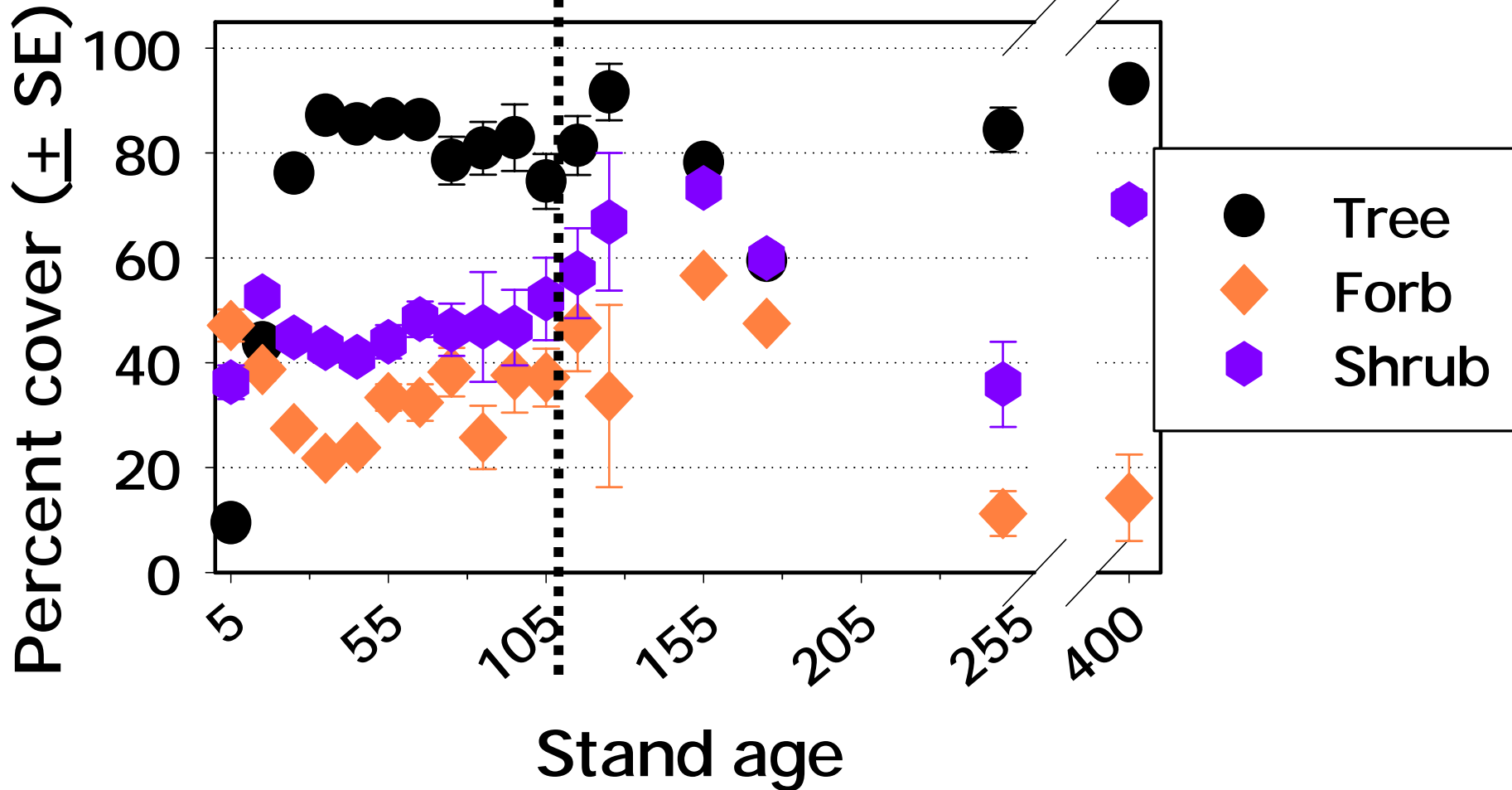
- **Aesthetic value (I'll know it when I see it!)**
- **Developmental phase (may look very different - and in the case of some boreal forests may be a bog!)**
- **Structural attributes (varies by forest type with some attributes never achieved in some forest types)**
- **Definitions applied with the purpose of identifying relatively old and relatively undisturbed forests in human-dominated landscapes**

Successional Gradient

Wet Conifer – Western Oregon



Vegetation Cover Wet Conifer



Franklin Model for Discussion

1. Disturbance and legacy creation
2. Cohort establishment
3. Canopy closure
4. Biomass accumulation/ Competitive exclusion
5. Maturation
6. Vertical Diversification
7. Horizontal Diversification
8. Pioneer cohort loss

* Article discussion this week focuses on the Franklin model *

Disturbance and Development

Disturbance types are frequently tied to specific phases of stand development:

- **Some insect outbreaks tend to be in SE stands**
- **For bark beetles, tree diameter is critical**
- **For defoliators, stress of competition often allows endemic populations to reach epidemic populations**
- **Fires require buildup of fuels, wind topples tall trees**
- **Root pathogens require continuity of host roots**