

STAND DYNAMICS

ESRM 323

Stand Dynamics

- The study of change in forest stand structure with time, including stand behavior after disturbance
 - Life and death in the forest: once the forest is established, no plant starts or accelerates its growth unless something dies or is killed freeing up growing space (physical space, above/below ground, light, water, nutrients, carbon dioxide, etc.)
 - All silviculture procedures are in part a simulation of natural processes
 - New Stand initiation events (natural & lethal): fire, pest outbreaks, windstorms, landslides, other atmospheric agents

Cohorts and Age Classes

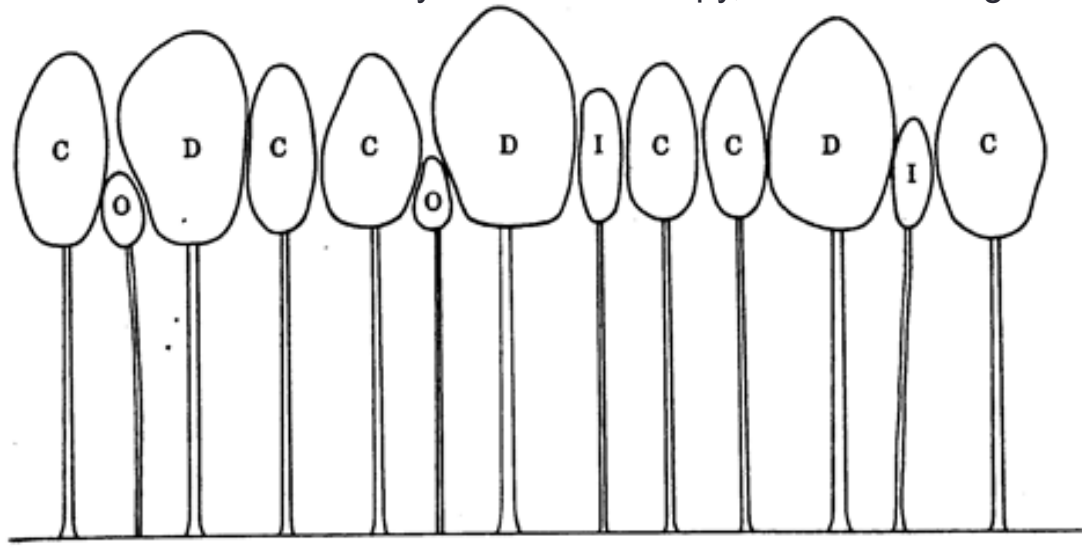
- Cohort – An aggregation (group) of trees starting as a result of a single (i.e. same) disturbance.
- Age Class – A range of tree ages within a stand
 - 3 basic age-class defined stand types:
 - Even aged or single cohort
 - Two aged or double-cohort
 - Uneven aged or multiple cohort (3+ age classes)
 - 2 types: Balanced and Irregular
- “Age class” is NOT always synonymous with “cohort”
 - A single age class can be a cohort, but a cohort is not always a single age class
 - Chronological age vs. effective age

Identification of Age-classes

- Identification of Age-classes
 - Use the profile of the top of the stand to determine the age distribution or to identify cohorts
 - Diameter alone is NOT a very good indicator of age – the sole *accurate* way to assess age structure is to count annual rings on a sample of trees!
- **Even-aged stands** tend to be “smooth” on top, whereas **uneven-aged stands** have distinctly irregular heights; the greater the # of age classes/cohorts, the more uneven the canopy.
 - Two exceptions: 1) very old stands have culminated in height growth at a common level and 2) isolated older trees that remained after disturbance may have decelerated in growth and younger trees have caught up

Crown Classes

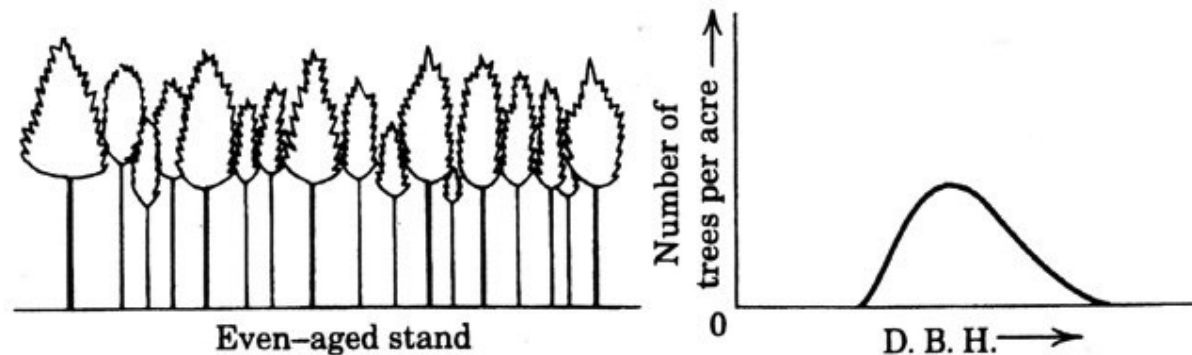
- **Dominant:** crowns extend above the general level of canopy receiving full light from above & partial from sides; larger than average size
- **Co-dominant:** crowns are in the general level of the canopy receiving full light from above, comparatively little from sides
- **Intermediate:** shorter than dominants and co-dominants, crowns do reach into the general level of the canopy, receive some full light from directly above, none from sides
- **Overtopped:** trees with crowns entirely below the canopy, no direct sunlight from above (suppressed)



- The process by which the “rich get richer” is crown differentiation

Even-Aged / Single Cohort Stand

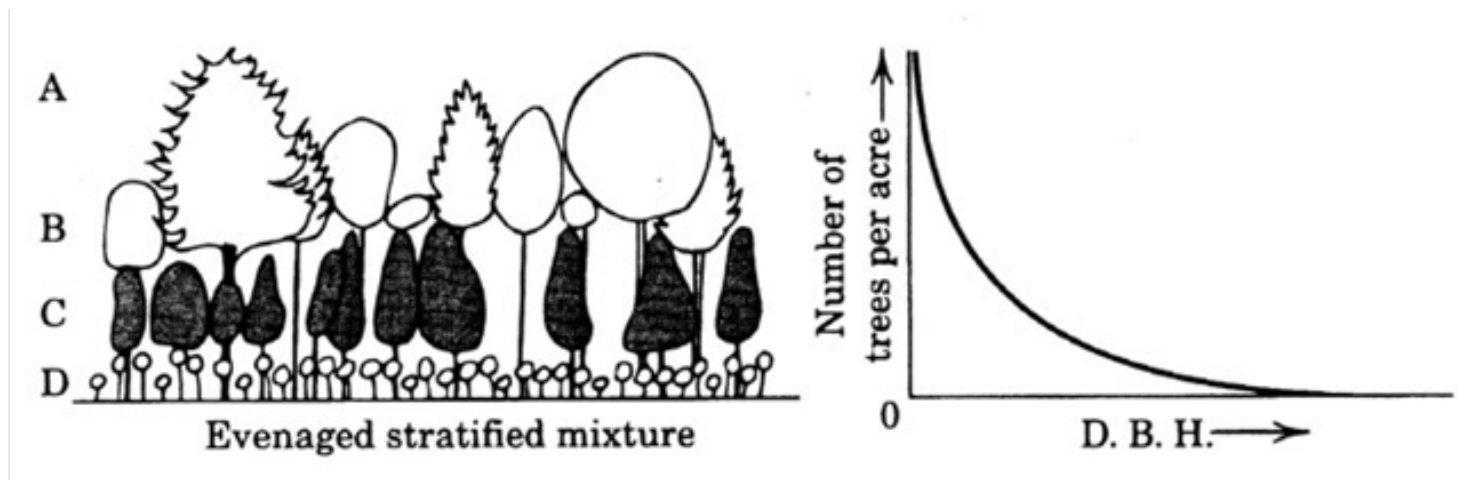
- If the range of all the ages of trees in the cohort, it is considered a single age class or even-aged stand.
- Very common in nature or man-made environments



- Growth in height is the most critical factor in competition – “race for the sky”

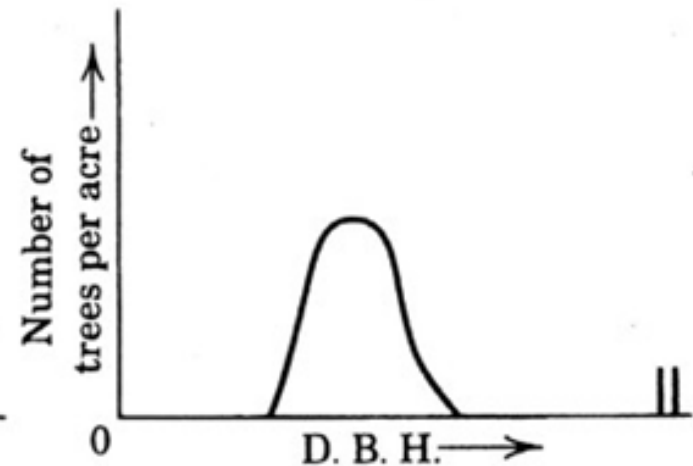
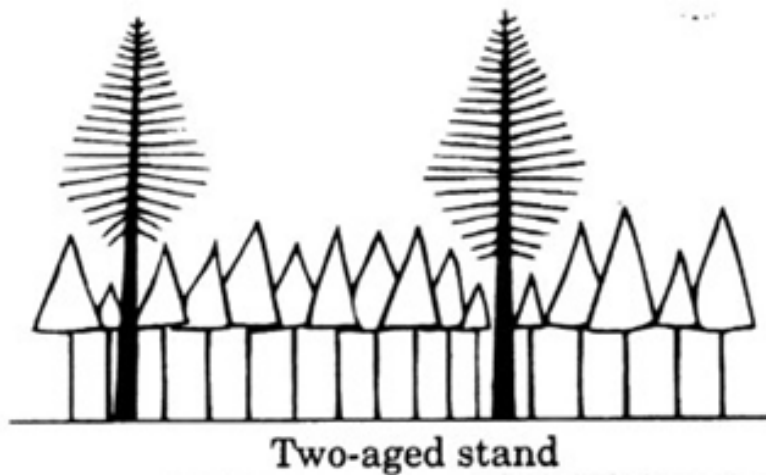
Even-Aged Stratified Mixture

- Same principle as an Even-aged stand, but more than one species is present
- Different species represented by advance regeneration, sprouts, new seedlings or combinations of all three start off together.
- Canopy strata (crown layers) develop because of differential height growth of species, shade tolerance, rooting depth, differing asymptotic height potential, etc.



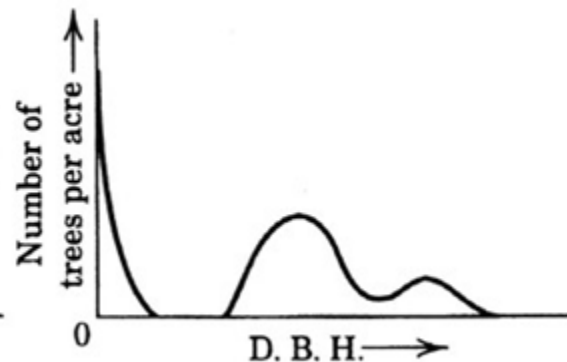
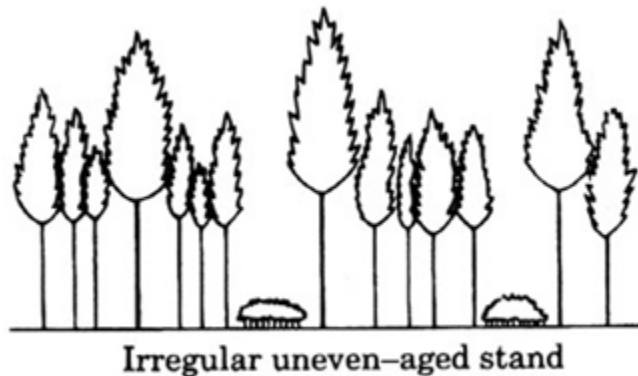
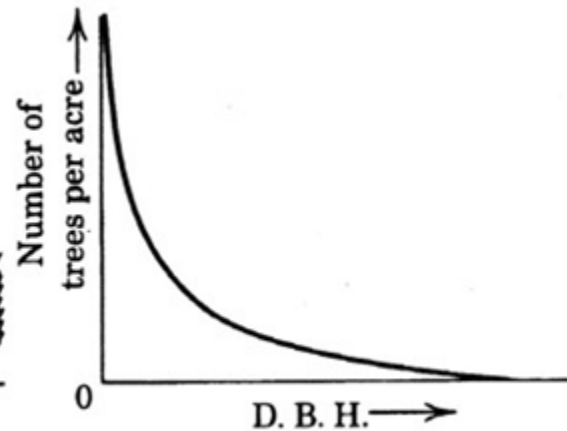
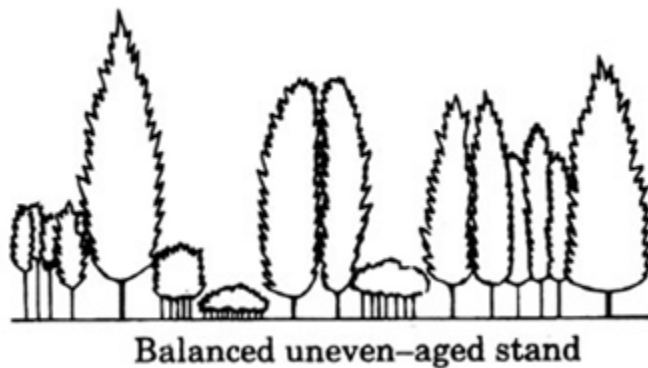
Two-Aged / Double Cohort Stand

- May arise naturally by fire
- Can be pure or mixed species
- Certain regeneration harvest cuts (leave trees) can lead to this type of stand



Pure, Uneven-Aged / Multi-cohort Stands

- Small gaps, created by cutting or destructive events give rise to new cohorts.
- Natural stands most commonly exist in places where soil moisture limits the habitat to one species

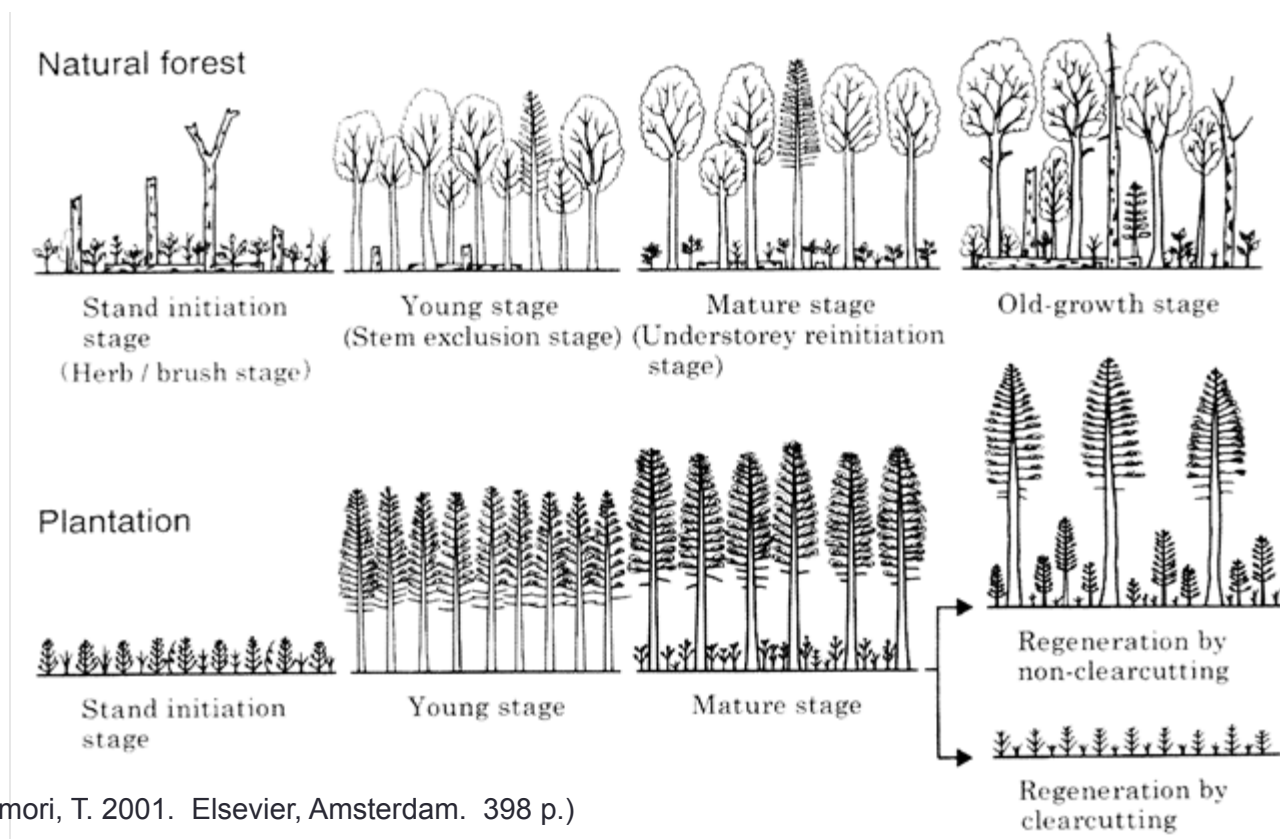


Mixed, Uneven-Aged / Multi-cohort Stands

- Arise from a history of partially effective or patchy lethal disturbance.
- All stages of stand development likely to be going on at once.
- Mixtures of age-classes, cohorts, fragments of stratified mixtures are all possible
- May be the result of “high-grading”

Stages of Stand Development

- Stand development stages must be recognized in order to use silviculture to imitate, guide, or alter natural processes



(From: Fujimori, T. 2001. Elsevier, Amsterdam. 398 p.)

Stand Initiation (Reorganization) Stage

- After a lethal disturbance creating a chunk of vacant growing space, the trees that may become established do not fully occupy the growing space (before canopy closure).
- Additional plants can “fill in” the available space, lasting up to ten years or more.
- Biodiversity is very high, perhaps highest of all stages.

Stem Exclusion (Aggradation) Stage

- After sufficient time, the growing space has become occupied, crowns become closed forming a continuous canopy, base of crowns begin to rise up due to death of lower branches due mainly to shading from upper foliage.
- More vigorous trees seize the growing space of weaker; weaker trees die from lack of light, moisture, suppression.
- Rapid leaf area accumulation occurs during this stage.
- Economic or financial rotation of even-aged crops usually occurs during this stage.
- Heavy shade, biodiversity is probably at its lowest.

Understory Re-initiation (Transition) Stage

- Trees that have been previously successful in competition with other trees begin to be lost by pests, other damaging agents, cutting operations; crowns do not fully close again.
- Gaps created are filled by new plants – often advance regeneration of shade tolerant species – but grow little or slowly.
- Total biomass (living + dead) begins to decline from its peak during stem exclusion stage.
- Forest floor herbs, shrubs re-appear.
- Medium shade.

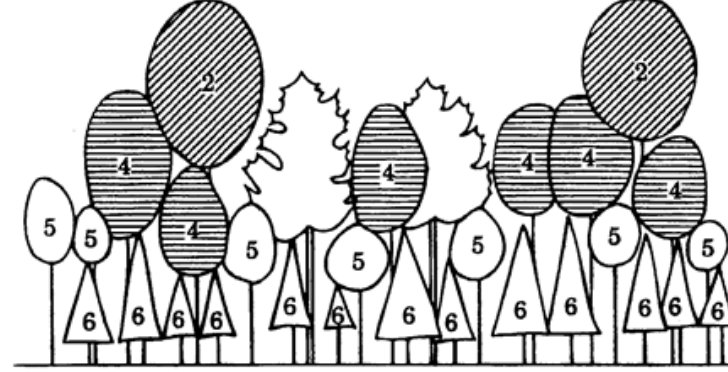
Old Growth (Steady state) Stage

- Characterized by fewer than half of trees in original cohort remaining, one or more new age classes (cohorts) compose parts of the top canopy.
- May continue past the death of the last original trees ... likely to be unbalanced, production gains = losses to death and decay.
- Biomass remains fairly constant: fluctuates little around the area mean.
- Overstory trees die in irregular fashion, some understory or lower canopy trees begin growing into overstory.
- Living trees are comprised of a variety of sizes.
- Large old snags present, as well as large fallen trees (logs).

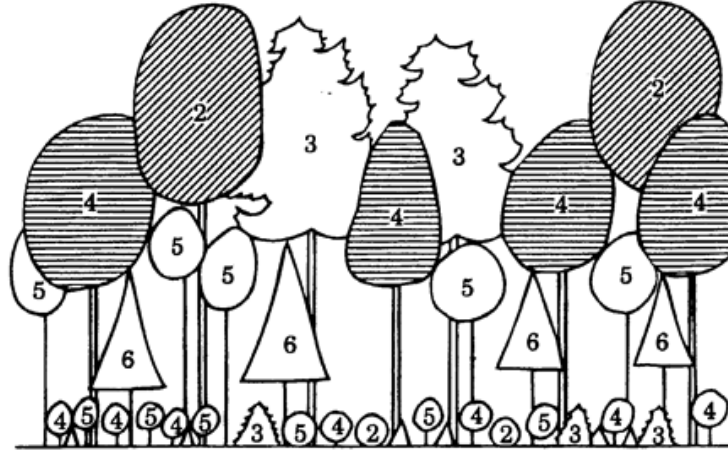
Stand
initiation



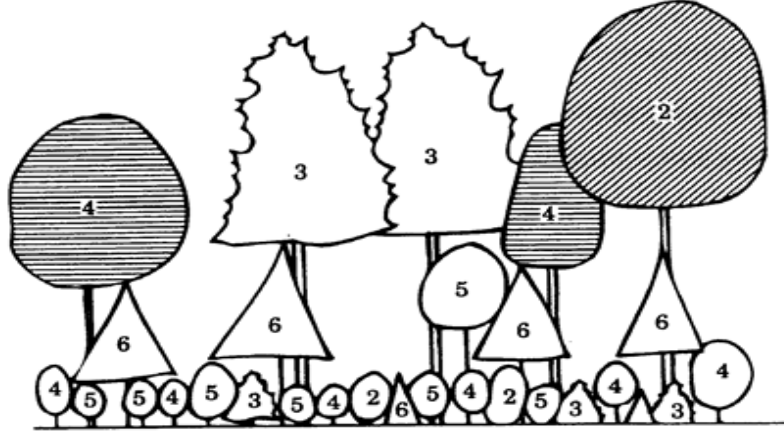
Stem
exclusion



Understory
reinitiation



Understory reinitiation



Old growth



Summary Ideas

- Stand Classification Criteria
 - Age distribution (constitution)
 - Species composition
 - Size distribution (structure)
 - Density
 - Site Quality
- Stand structures can be defined in many ways depending on region, objectives, or other biological and non-biological factors. For example:
 - Tree size classes: seedlings (a few feet tall < 1" DBH), saplings (4.5+ ft tall up to 4" DBH), pole (4 – 10" DBH), small saw (11 – 24" DBH), large saw (24+ inches)
 - Other definitions of stages ("savanna," "open," "ancient," ...)

Summary Ideas (Cont.)

- Silvicultural choices may be thought of as determining what kind of stand development process or stage of natural succession is most desirable in a given situation
- Silvicultural practices often focus on actively encouraging stands to develop toward structures that are in short supply, recognizing that stands will become increasingly more valuable as they accumulate attributes of the desired structure