Introduction to Forest Stand Dynamics
Stand Dynamics

the study of changes in forest stand structure with time, including stand behaviour during and after disturbances
Seminar

• The word seminar is derived from the Latin word seminarium, meaning "seed plot".

• It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to actively participate.
Jan. 4      Monday  Introduction to Stand Dynamics
Jan. 7      Thursday Plant interactions and limitations to growth
Jan. 11     Monday  Plant interactions and limitations to growth
Jan. 14     Thursday Tree architecture and growth
Jan. 18     Monday  Tree architecture and growth
Jan. 21     Thursday Disturbances
Jan. 25     Monday  Overview of stand development patterns
Jan. 28     Thursday Temporal and spatial patterns of tree invasion
Feb. 1      Monday  Readings I
Feb. 4      Thursday Stand initiation stage
<table>
<thead>
<tr>
<th>Date</th>
<th>Day</th>
<th>Event</th>
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<tr>
<td>Feb. 8</td>
<td>Monday</td>
<td>HOLIDAY (Family Day)</td>
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<tr>
<td>Feb. 11</td>
<td>Thursday</td>
<td>Stem Exclusion stage</td>
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<tr>
<td>Feb. 15</td>
<td>Monday</td>
<td>WINTER BREAK</td>
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<td>Feb. 18</td>
<td>Thursday</td>
<td>WINTER BREAK</td>
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<td>Feb. 22 *</td>
<td>Monday</td>
<td>Stem Exclusion stage</td>
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<td>Feb. 25</td>
<td>Thursday</td>
<td>Stem Exclusion stage</td>
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<td>Feb. 29</td>
<td>Monday</td>
<td>Readings II</td>
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<td>Mar. 3</td>
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<td>Understory reinitiation</td>
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<td>Mar. 10</td>
<td>Thursday</td>
<td>DEMO Discussion</td>
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<td>Mar. 14</td>
<td>Monday</td>
<td>Old growth</td>
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<td>Mar. 17</td>
<td>Thursday</td>
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<tr>
<td>Mar. 21</td>
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<td>Mar. 24</td>
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<td>Mar. 28</td>
<td>Monday</td>
<td><strong>HOLIDAY</strong> (Easter Monday)</td>
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<td>Mar. 31</td>
<td>Thursday</td>
<td>Stand Models</td>
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<td>Apr. 4</td>
<td>Monday</td>
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<tr>
<td>Apr. 8</td>
<td>Thursday</td>
<td>Landscapes and Summary</td>
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Webpage

• http://frst537c.forestry.ubc.ca/
Grading

• Group work/poster  20 points

• 80 points
  – Undergrads – Final
  – Grads - Term paper (approx. 10 pages)

  – *(see me if you want a midterm option for 20 points)*
Introduction to Forest Stand Dynamics
Systems Thinking

• What is a system?

• Systems - complexes of elements standing in interaction (von Bertalanffy, 1968)

• Why systems?
Types of Systems

• Closed
  – Isolated from their environment
  – Lab experiments: everything is stable and controlled

• Open
  – Influx and outflow of energy
  – Every living organism

• Complex
  – Combination of open and closed systems
Complex Adaptive Systems

They are **adaptive**; in that the individual *and* collective *behaviour* mutate and self-organize corresponding to the change-initiating micro-event or collection of events.
Open Systems

• More applicable to biological sciences

• Forests, ecosystems, trees = open systems

• Influx and outflow of nutrients, light, matter
Rules of Systems

• Entropy or Evolution theory?
  – Contradiction
  – Entropy is positive in closed systems
  – Entropy may be balanced off by system production in open systems
History of Evolutionary Thinking

• 1850s – most 20\textsuperscript{th} century: systems come to a stable end
  – Darwin: nature $\rightarrow$ humans
  – Marx: economy $\rightarrow$ communism
  – Clements: ecosystem $\rightarrow$ climax

• 1910-present:
  – Gleason: community variation and importance of chance events
  – Holling: stages and adaptive cycles
What is a “paradigm”?  

In *The Structure of Scientific Revolutions*, Thomas Kuhn describes a paradigm as:

a set of beliefs, theories, or a world view that is unquestioningly accepted and has become established as "truth."
Holling

OPEN
UNDERSTORY
DENSE
??
Stand Dynamics

- *Forest stand dynamics* – the study of changes in forest stand structure with time, including stand behavior during and after disturbance.

- *Stand* – spatially continuous group of trees and associated vegetation having similar structures and growing under similar soil and climatic conditions.
Stand Dynamics

• Studying stages of development (cycles) in an open system

• Studying patterns of stand development
  – Characteristics of emergent properties (e.g. species dominance)
  – Connectedness of system elements (e.g. mixed-species stands)
  – Speed of transition (disturbance and/or site quality)
Focussing on patterns opened door to transfer of experience and knowledge from one geographic area to another

Systems approach
The Stand?

• Forest Types
• Stands
• Sub-stands
• Strips or clumps
• Groups
• Individuals

– James Toumey, *Foundations of Silviculture*, 1928
These divisions are drawn from more or less artificial bases and are of temporary importance.
Stand Dynamics Among Disciplines

**DERIVED DISCIPLINES**
*(INTEGRATION)*

- SILVICULTURE
- PALEOBOTANY
- MENSURATION
- SUCCESION
- ECOSYSTEM
- STATISTICS
- FOREST STAND DYNAMICS
- SOILS
- TREE PHYSIOLOGY
- ATMOSPHERIC SCIENCE
- PHYSICAL CHEMISTRY
- BIOCHEMISTRY
- CHEMISTRY
- PHYSICS
- SUBATOMIC PHYSICS
- MATHEMATICS

**FUNDAMENTAL DISCIPLINES**
*(CAUSALITY)*

Oliver and Larson, 1996
Why do patterns keep appearing?

• The big picture
Floral Regions

Floral Kingdoms:
- Boreal (Holarctic)
- Neotropical
- Australian
- Paleotropical
- South African (Capensic)
- Antarctic

Legend:
- Subkingdom boundary
- Region boundary
- Division boundary

Note: The full extent of the Antarctic Kingdom is not marked on this global map. It has numerous tiny "pockets" in southeastern Australia, New Zealand, and Antarctica.
Continental Drift

- 320 million years ago
  - Gondwana
- 250 million years ago
  - Pangaea
- 135 million years ago
  - Gondwana
- 100 million years ago
  - North America, Eurasia
- 45 million years ago
  - North America, Eurasia, Africa, Australia
- Present day
  - North America, Eurasia, Africa, Australia

Extinction event
Prevailing Winds

- Blue: westerlies
- Yellow: trade winds (northeasterly)
- Orange: trade winds (southeasterly)
1: hurricanes
2: cyclones
Ocean Currents
Although stand dynamics needs to have a systems rather than a reductionist approach, the patterns of development make most intuitive sense when individual trees are considered in the simplest of terms.
Chaos theory

- Pattern bigger than the process
- Mandelbrot set
- Fractals
Mandelbrot set example

\[ X_{(n+1)} = (X_n)^{(2+k)} \]
$K = -0.1$
$k = -1.3$
$k = -1.9$