Succession in Plant Communities

Reading Assignment: Ch. 12 in GSF

What is plant community succession?

- Directional ecosystem change through time occurring on time scales of decades to centuries.
  - Autogenic – caused by organisms themselves (litter or peat accumulation, N fixation, light limitations…)
  - Allogenic – caused by external forces (disturbances such as fires, hurricanes, etc.)

Succession is Response to Disturbance

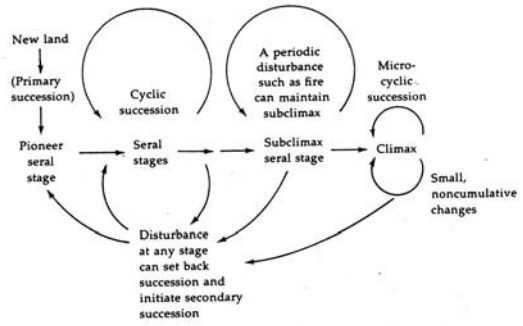
"A disturbance is any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment." White and Pickett, 1985.

Disturbance regimes are characterized by size, intensity, and frequency

Compare/contrast fire regimes in lodgepole vs ponderosa pine

- Size
- Intensity
- Frequency
- Biotic residual
- Type of stand

Successional development is directional, potentially proceeding from a "pioneer ecosystem" through several seral stages to a "climax ecosystem"



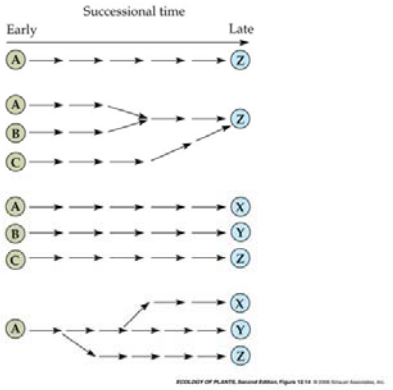
The Sere Concept

- Entire process of succession from beginning to end is called a "sere"
- Each distinct community type along the way is a seral stage
- Change occurs at all seral stages
- A state of dynamic equilibrium may occur if and when climax community is reached
- This concept is still applicable in some cases

What is a climax community?

- Polyclimax vs monoclimax theory
  - Clements: All succession leads to one climax type in a certain area owing to the pervasive influence of climate at broad scales
  - Gleason: Individual species respond to environment individualistically; continuum of community types
  - Whittaker proposed that every point along an environmental gradient has a different climax ecosystem (aka “pattern climax”)

Hypothetical Successional Trajectories



Types of Succession

- Primary succession – invasion of an area previously unvegetated, without soil, seeds or spores
  - follows catastrophic disturbance such as lava flow, shoreline advance, glaciation
- Secondary succession – invasion of land previously vegetated with soil and propagules
  - follows major disturbance such as fire, wind, logging

9/16/09 Dunes at Lake Michigan studied by Cowles 10

Dunes at Lake Michigan studied by Cowles

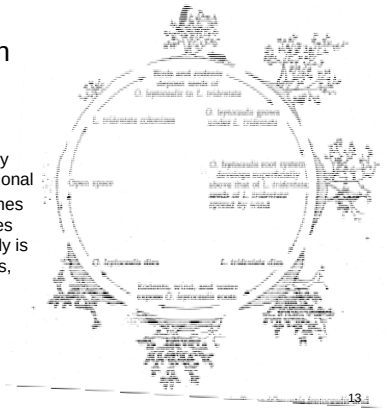
9/16/09 Photo credit: Brad Slaughter
http://web4.msue.msu.edu/mnfi/communities/community.cfm?id=10679 11

Next week we will read and discuss a chronosequence study of primary succession following glaciation in Alaska (Fastie paper)

9/16/09

Types of Succession

- Cyclic succession – disturbance processes maintain a cycle of early seral stages; not directional
- Here creosote establishes in open space, facilitates cholla cactus, eventually is out-competed by cactus, then cactus dies and leaves bare soil

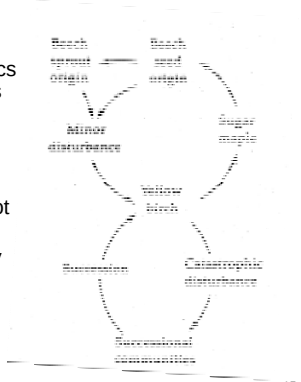


Types of Succession

- Gap dynamics - small-scale, minor disturbances such as tree-fall, gopher mounds, etc.
- Communities are viewed as a mosaic of patches
- Now a common view

Gap Dynamics

- Example of gap dynamics in an Eastern deciduous forest
- In this view, a minor disturbance results in small changes in dominant species but not succession
- Contrast with secondary succession (major changes in community composition) following large disturbance



Theories of successional processes

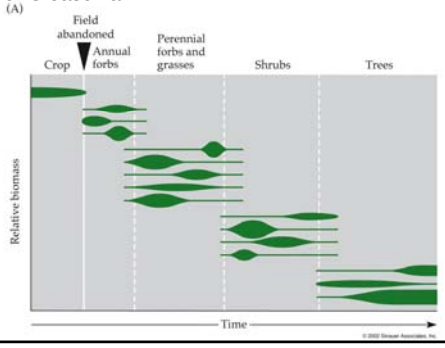
- Clements' Six Stages
  - nudation (disturbance starts succession)
  - migration (influx of plant propagules)
  - ecesis (establishment, development, growth)
  - competition (among plants)
  - reaction (alteration of environment by plants)
  - stabilization (climax)
- Steps 2-5 would be repeated as new communities (seral stages) became established

Theories of successional processes

- In the 1950's, Egler described 2 possible scenarios for succession, relay floristics and initial floristics

Relay floristics:
–Succession of unique communities or seral stages
–Focused on primary succession
–Clementsian or Gleasonian?

Fig. 12.13



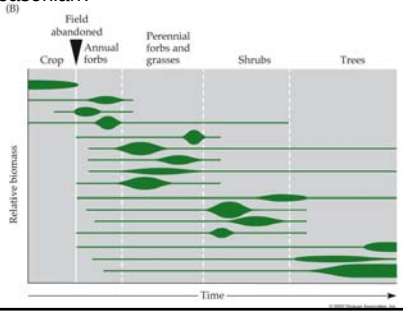
Initial floristics:

• All species present at start of secondary succesion, as propagules in soil (seed bank)

•Species become dominant at different times, depending on life history

•Clementsion or Gleasonian?

Fig. 12.13



Theories of successional processes

Connell and Slatyer (1977) suggested that succession is driven by one of three over-riding mechanisms, facilitation, tolerance or inhibition

- Facilitation: pioneer species modify the environment, making it favorable for other species
  - Similar to Relay floristics

The palo verde sheltering the saguaro cactus is a classic example of facilitation

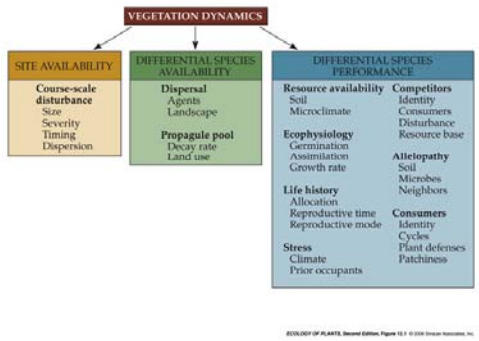
Theories of successional processes (Connell and Slatyer, con't)

- Inhibitition: early successional species monopolize resources, outcompeting later species until conditions change
- Tolerance: species neither help nor hinder colonization by other species, but just wait their turn
  - Similar to initial floristic composition
  - Long-lived, large trees tolerate early inhibition

Theories of successional processes

"Succession is a process in which species that are present for much of the time become dominant at different times. Invasion and extinction are not the major mechanisms of community change. . . Many species which are important later in the sequence invade early." -Steward Pickett

Now we recognize many factors affecting succession!



Theories of successional processes

- More recently, Grubb defined the "regeneration niche" as the set of environmental conditions required for a plant species to reproduce
- Colonizers in primary succession often differ from those in secondary succession

Theories of successional processes

Rates of colonization and change during secondary succession depend on:

- Patchiness of disturbance
- Persistence of "safe sites"
  - Intensity of disturbance
  - Persistance of propagules (seeds, sprouting roots, etc.)
- Environmental conditions after the disturbance

Do climax communities really exist?

Do plant communities ever really reach equilibrium?