Ecosystems in Time

lecture 3
Objectives

- Describe the effects of **disturbance**, or lack thereof, in (natural and managed) ecosystems and explain its relationship to the process of biological **succession**.

- Define the term **invasive species**, give an example of an invasive plant or animal and describe its impact on an ecosystem.

- Distinguish between the terms "**primary succession**" and "**secondary succession**" and describe some examples of each.

- Distinguish between the terms "**soil**" and "**mineral substrate**".

- Describe how **pioneer species** in primary and secondary succession change nonliving components of an ecosystem (temperature, light, moisture, humidity, mineral substrate, etc.) during the early stages of succession.

- Give an example of a biological community that is maintained in an early stage of succession by repeated disturbance and describe the **disturbance regime** and its effect on the community.
Ecosystems are dynamic
Ecological Succession

“Change in species composition of a community over time”
Ecological Succession

- Generally thought of as directional and predictable
- Structured by competition
- Each stage modifies abiotic environment, suppresses previous
- Focus on plants (especially forests), but can occur in many communities
Succession affects habitat suitability for wildlife
Primary Succession

- Follows the formation of **new land surfaces** consisting of rock, lava, volcanic ash, sand, clay, or some other exclusively mineral substrate

- **NO SOIL**

Glacier Bay, Alaska
Mt. Saint Helens: 1973 – Prior to eruption
Mt. Saint Helens: 1983 – 3yr post-eruption
Mt. Saint Helens: 2000 – 20 yr post-eruption
Soils
a living system

- Soil is a mixture of **mineral** material, decaying organic material, and **living** organisms
- Soil formation, or pedogenesis, is the combined effect of physical, chemical, and biological processes on soil parent material
Secondary succession

- Follows the destruction or partial destruction of the vegetation of an area by some sort of disturbance, like a fire, windstorm, or flood that leaves the soil intact.
Regeneration may occur from:

- Seed bank: seeds already in the soil
- Seed dispersal: seed arriving from elsewhere
- Resprouting: new growth from roots in the soil
- Advanced regeneration: plants that survived disturbance
Old Field Succession

Follows abandonment of agricultural land
Pioneer Species

- First species to arrive
- Soil stabilization
- Soil nutrient enrichment
  - organic matter
  - biological nitrogen fixation
- Increased moisture holding capacity
- Reduced light availability
- Moderation of temperature extremes
- Reduced exposure to wind

Pioneer traits:
- Small seed
- Stress tolerant
- Fast growth
- Shade-intolerant
- Short lived
Mid-Succession

- Pioneers are not self-replacing due to shade-intolerance
- Able to recruit in moderate shade of the pioneer species
- Require developed soils
- Less stress tolerant
- Medium seeds
Climax Community

- Highest shade-tolerance
- Self replacing
- Poor dispersal
- Moist, fertile environments
- “Old-growth”
Early Hardwood

Southern Pine

Southern Mid Hardwood

Northern Pine

Northern Mid Hardwood

Mid Conifer

Late Hardwood

Late Conifer

Evergreen

Hydric

Hardwood
Disturbance resets succession

- Fire
- Wind
- Landslides
- Treefall
- Land use
- Insect outbreaks
- Droughts
- Floods
Disturbance Regimes

- Many communities are often held at earlier successional stage by repeated disturbances
- Species are adapted to the dominant modes and frequencies of disturbance in a community
- The three factors that characterize a disturbance regime are:
  - Size
  - Frequency
  - Intensity
Illinois Prairie

- Early successional grass and perennial plants are fire tolerant and resprout.
- Repeated fires destroy woody species that would change the environment and eventually result in the establishment of a deciduous forest.
- Moderate intensity, high frequency, large extent.
Western Wildfire
Western Wildfire

- Frequent
- Low intensity
- Patchy

- Infrequent
- High intensity
- Uniform
Summary of changes that occur during succession

- Pioneer species colonize first.
- Pioneer species alter the environmental conditions remaining after the disturbance.
- Eventually new species of plants become established in the conditions altered by the pioneer species and displace the pioneer plants.
- Animals come in with or after the plants they need to survive.
- Further environmental change by the new plants and animals result in the establishment of different species.
- With infrequent disturbance, a stable climax community consisting of plants and animals that can reproduce themselves in the existing conditions will become established.
- Disturbance of the ecosystem will start the process of succession anew.
- In a given area there are usually small patches of land in different stages of succession, depending on the time and severity of the last disturbance. This adds diversity in the types of vegetation and animals living in the greater region.
Global Warming Era
Weather Graphics

MON TUES WED THURS FRI
WILD-FIRE

HURRICANE FLOOD LOCUSTS RESPONSE

NO
FROGS?
EXTINCT.
Invasive species

- Non-indigenous species that adversely affect the habitats they invade economically, environmentally or ecologically
- Alter ecosystem function
- Impact ~80% of endangered species
- Total costs of invasive species in the United States amount to more than $100 billion each year
- Includes plants, herbivores, predators, and diseases
Zebra Mussel

Purple loosestrife

Brown tree snake

Hemlock Woolly Adelgid

Kudzu

Chestnut blight

Sea lamprey

Emerald Ash Borer