Chapter 10: Ecological Restoration

Restoration Ecology
• New field of restoration ecology developed within the science of ecology.
  – Goal = return damaged ecosystems to some set of conditions considered functional, sustainable and “natural”.
• Restore to what?

Balance of Nature
• Predominant belief that left undisturbed an ecosystem would achieve a single condition that would persist indefinitely.
• Major tenets of this belief
  – 1. Nature undisturbed achieves a permanency of form and structure that persists indefinitely
  – 2. If it is disturbed and the disturbing force removed, nature returns to exactly the same permanent state.
  – 3. In this permanent state of nature, there is a “great chain of being” with a place for each creature.

Balance of Nature
• Twentieth century ecologist formalized the belief in the balance of nature
  – Climate state – steady-state stage that would persist indefinitely
    • Maximum biological diversity
    • Maximum storage of chemical element
    • Maximum biological diversity

Balance of Nature
• Since the second half of the 20th century ecologist have learned that nature is not constant.
  – All ecosystems undergo change
  – Species adapted to and need change
• Dealing with change poses questions of human value
  – Controlling and managing fire

Boundary Waters Canoe Area Wilderness
• 400,000 hectares in N Minnesota designated as wilderness
  – Closed to logging and other direct disturbance
• Area has a natural history of fire
  – On average area burns once a century
  – When they occur at natural rate they have beneficial effects
  – Landscape depends on change (dynamic)
Goals of Restoration

- Frequently accepted that restoration means restoring an ecosystem to its historical range of variation and to an ability to sustain itself and its crucial functions
  - Cycling of chemical elements
  - The flow of energy
  - Maintenance of biological diversity

Goals of Restoration

- Science tells us what nature has been and what it could be.
- Our values determine what we want nature to be.
  - There is no single perfect condition.

What Needs to be Restored?

- Ecosystems of all types have undergone degradation and need restoration.
- Once again discussions about restoration involves values.

Wetland, Rivers, and Streams

- Estimated that CA has lost 90% of its wetlands.
  - The US about 50%
- Kissimmee River in Florida
  - Channelized to provide ship passage
  - Now under going restoration at cost of several hundred million dollars
Prairie Restoration

- Prairie once occupied more land in US than any other kind of ecosystem.
  - Only a few remnants remain
  - Land converted to agriculture
- Two kinds of restoration
  - Intact prairie (never been plowed)
  - Previously plowed land more complicated to restore

The Process of Ecological Succession

- Recovery of disturbed ecosystems can occur naturally, through a process of ecological succession.
- Primary succession
  - The initial establishment and development of an ecosystem where one did not exist previously
- Secondary succession
  - Reestablishment of an ecosystem following disturbance

Patterns of Succession

- When succession occurs it follows certain general patterns.
  - Three examples include dunes, bog and abandoned farm field
Dune Succession

- Sand dunes continually formed along sandy shores.
  - Then breached and destroyed by storms
- After dune forms
  - First to be established are grasses
  - Grass runners stabilize dunes
  - Other species seeds may germinate and become established

Dune Succession

- Plants of early succession tend to be
  - Small, grow well in bright light, and withstand harshness of environment
- Over time larger plants can become established
  - Eastern red cedar, eastern white pine
  - Beech and maple later on

Bog Succession

- A bog is an open body of water with surface inlets but no surface outlets.
- Succession begins with
  - Sedge puts out floating runners
  - Wind blows particles into the mat of runners
  - Seeds that land on top don’t sink in the water and can germinate
  - Mat becomes thicker and shrubs and trees can grow

Bog Succession

- The bog also fills in from the bottom
  - The shoreward end floating mat and sediment will meet, forming a solid surface.
  - Farther from shore all the vegetation is still floating
Old-Field Succession

- A great deal of land cleared for farming in the 18th and 19th centuries
  - That land now allowed to go back to forest
- Succession
  - The first plants to enter the farm land are small plants adapted to harsh and variable conditions.
  - After they are established larger plants move in.

General Patterns of Succession

- Common element include the following
  - 1. An initial kind of vegetation specially adapted to the unstable conditions.
    - Typically small
    - Help stabilize physical environment
  - 2. A second stage with plants still of small statute, rapidly growing, with seeds that spread rapidly.

General Patterns of Succession

- 3. A third stage in which larger plants, including trees, enter and begin to dominate the site.
- 4. A forth stage in which mature forest develops.

General Patterns of Succession

- Successional stages
  - Early (1 and 2), middle, and late
- Similar patterns seen with animals and other life-forms at each stage.
  - Species characteristic of early stage are called pioneers
  - Late-successional species tend to be slower-growing and longer-lived

General Patterns of Succession

- In early stages of succession
  - Biomass and biological diversity increase
- In middle stages
  - Gross production increase and net production decrease
  - Organic material in soil increases, as does chemical element storage
Succession and Chemical Cycling

Storage of chemical elements generally increases during progression from early to middle for two reasons.
- 1. Organic matter stores chemical elements
  - As one increases the other will increase
  - Nitrogen fixation

Succession and Chemical Cycling

As general rule, the greater the volume of soil and the greater the % of organic matter in the soil, the more chemical elements will be retained.
- Varies with average size of soil particles

Succession and Chemical Cycling

The chemical storage capacity of soils varies with average size of the soil particle.
- Large coarse particles, like sand, have a smaller total surface area and can store a smaller quantity of chemical elements.
- Smaller particles, like clay, store greater quantity of chemical elements.
- Soils store large quantities of c.e. but not as readily available as those in living organisms.

Succession and Chemical Cycling

The increase in chemical element does not continue indefinitely.
- With no disturbance ecosystem will have a slow loss of stored chemical elements
  - Becoming depauperate
Species Change in Succession

- Earlier and later species in succession may interact in three ways
  - Facilitation
  - Interference
  - Life history differences
- If they don’t interact the result is chronic patchiness

Facilitation

- In the dune and bog the facilitators are the dune grass and floating sedge, respectively.
  - They prepare the way for other species
- Knowing the role of facilitation helps with restoration
  - These plants can be planted first

Interference

- Certain early species interfere with the entrance of other species.
  - Grasses may form dense mats blocking other seeds from germinating.
  - Breaks in the mat allow other to be established
Life History Differences

• An example of life history differences is seed dispersal.
  – Early-successional species are readily transported by wind or animals.
    • Reach clearing sooner
  – Late-successional species seeds take longer to travel and seedlings can tolerate shade.

Chronic Patchiness

• Common in deserts
  – Major shrub species grow in patches
  – Patch persist for long period of time until next disturbance.
• Life tends to build up, aggrade
• Non-biological processes tend to erode or degrade.
  – In harsh environments degrading dominates and succession does not occur.

Applying Ecological Knowledge

• Undo mining damage in Great Britain
  – To remove toxic pollutants
  – Restore biological production
  – Restore attractiveness of landscape
• Agricultural approach failed
  – Grasses soon died and land was barren again
• Ecological approach has been successful
  – Planting early successional species