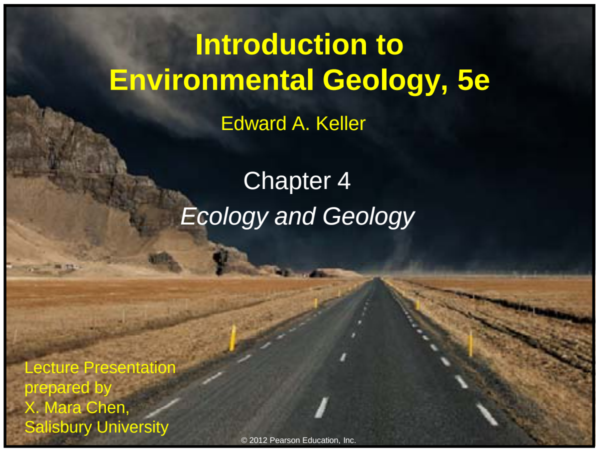


Case History: Endangered Trout in CA

- A study to evaluate the steelhead habitat in the Santa Monica Mountains near Los Angeles
- Steelhead trout are born in mountain streams and travel to the ocean, enjoy gravel-laden streams and low summer flow
- The eggs hatch in the gravel of the stream
- Groundwater emerges to the surface as seeps and springs along faults
- The geology (rock types and structures) and groundwater are important in understanding fish habitat.

Ecology and Geology Linkage

Ecology:

- Study of relationships between living things and their environments; the study of controls over the distribution, abundance and health conditions of living things

Environmental Geology

- Study of geological processes and their effects on environment

The linkage

- Complex linkages, varies at different ecological scales

Fundamental Ecology Terms

- **Species:** A group of individuals capable of interbreeding
- **Population:** A group of individuals of the same species living in the same area
- **Community:** A group of the populations of different species living in the same area
- **Biota:** All organisms living in an area or a region
- **Biosphere:** The part of Earth where organisms exist and function

Species

- Indigenous species: Found in the area where they evolved
- Exotic species: Brought into an area or a region by human purposely or accidentally
  - e.g., acacia trees: imported from Australia to arid regions as wind breaks
- Invasive species: Exotic species compete with indigenous species and may displace them

Ecosystem

- An ecological community and its surrounding environment in which the flows of energy and cycles of chemicals support a living community

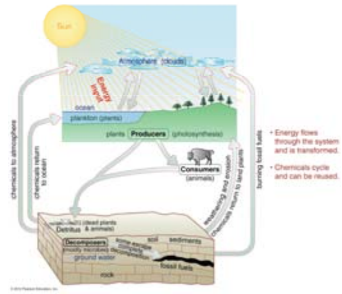
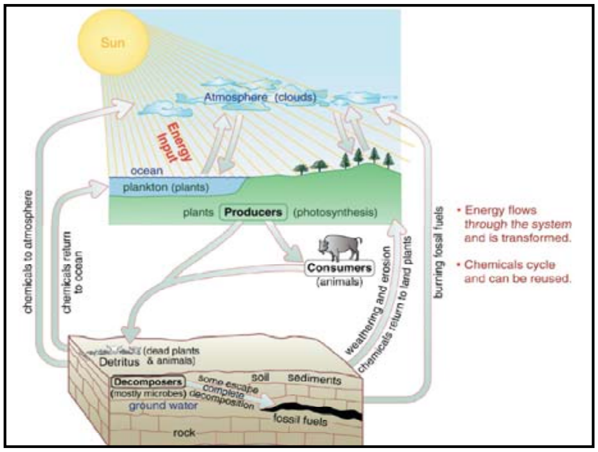


Figure 4.2



Types of Ecosystem

- **Natural Indigenous:** Ecosystem as the result of completely natural evolutional processes, rarely exist on land
- **Human modified:** The one modified by human use and interest, almost all the major ecosystems
- **Human constructed:** Man-made ecosystem for many different purposes at many sites, such as ponds, canals, wastewater treatment pools

Natural Service Functions of Ecosystems

Natural functions: The processes responsible for producing clean water, air and diverse living matters

- Direct functions
  - Cycle of chemical elements (e.g., CO_2, O)
  - Flow of energy and nutrients
  - Removal of pollutants
- Buffering functions: Providing protections from natural hazards (e.g. wetlands against coastal flooding and erosion)

Biodiversity

The number or abundance of species in an ecosystem or ecological community

- Species richness: The number of species
- Species evenness: The relative proportion of species
- Species dominance: One of multiple species more common than others
- Keystone species: Exerting a stronger community effect disproportionate to their abundance

Geology and Biodiversity

- Geology affects the overall environmental conditions of an ecosystem
  - Changes in topography (e.g., mountain building and slope movement)
  - Plate tectonics and ecosystem barrier (e.g., North America and Europe tree diversity vs. mountain range distribution)
  - Changes in climate: Ice age, glaciation, and global warming

Keystone Species (1)

- Keystone species: Species exert a strong community effects disproportionate to their abundance
- Case study: Wolf, elk and mountain stream system in the Yellowstone National Park
  - 1960s–mid-1990s: Elk overbrowsed the riparian vegetation, affected the stream ecosystem
  - late 1990s: Reintroduced wolves that hunted elks and promoted the growth of riparian vegetation, water quality, and stream ecosystem

Keystone Species (2)

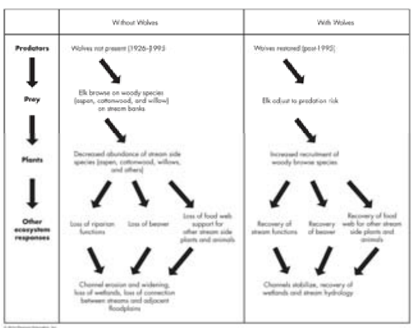
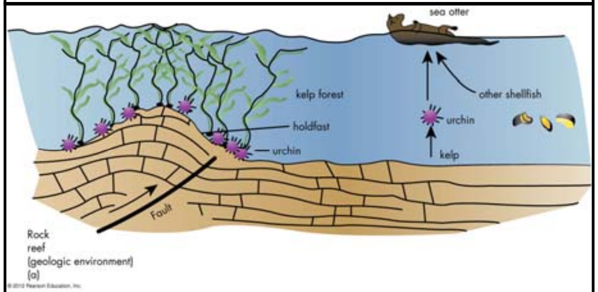


Figure 4.5

Keystone Species (3)

- Sea otters, urchins, and kelp
- Kelp forests: Three parts – root-like holdfast, stem (stipe), and blades (leaves)
- Holdfast attached to boulders or the rocky bottom, part of the active geological environment
- Urchins fed on the holdfast of kelp
- Sea otters restored and fed on urchins, kelp forests restored

Keystone Species (4)



Factors To Increase Biodiversity

- The presence of diverse habitat
- Favored geological environment
  - Moderate amount of disturbance – hazards creating or renewing habitats
  - Harsh environments for certain unique specialized species, increasing biodiversity at regional scale
- Relatively constant environmental conditions, such as T, P, precipitation, and elevation
- Highly modified biologically productive environment

Factors To Reduce Biodiversity

- Extreme geological environment
  - Extreme disturbances damage habitats
  - Limit the number of habitats and ecological niches at a local scale
  - Pollution and other stresses restricting the flow of energy and nutrients
- Fragmentation of ecosystems by land use transformation
- Intrusion of invasive exotic species
- Habitat simplification (engineering structure) or migration barriers

Human Domination

Human activities exerting dominant community effects

- Dominate almost all ecosystems on Earth
- Massive land use transformation – urban, agriculture, recreation and industry development
- Global climate changes
- Changes in biogeochemical cycles – O, CO_2, energy, and nutrients
- Most rapid extinction of many species during the last 2000 years

Case Study: Seawalls and Biodiversity

- Seawall: structures made of concrete, large boulders, or wood parallel to the shore with the objective of stopping coastal erosion
  - Beach space narrowed, and gradient increases of offshore slop
  - Waves are reflected, further narrows the beach
  - Fewer animals in the sand, fewer insects, fewer birds to feed and rest on the beach, reducing biodiversity

Case Study: Seawalls and Biodiversity

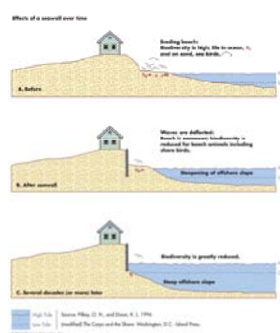
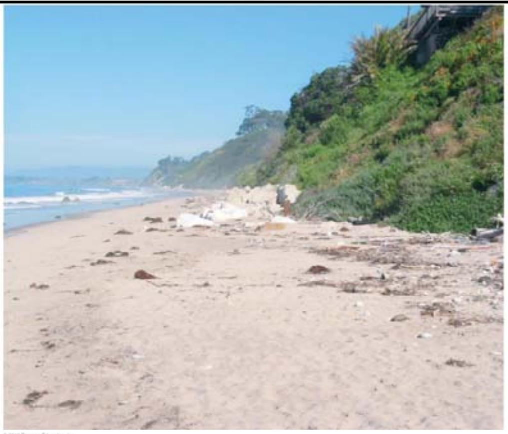


Figure 4.B



The Golden Rule of the Environment: All About Timing

- Geological processes on Earth time scale
- Human activities and expectations on human time scale
- Need to operate with an appropriate environmental ethic
- Need to make a "pact" with the Earth to achieve a more compatible relationship
- Disrespect and disregard resulting environmental degradation

Reduce the Human Footprint

- Total footprint: The product of the footprint per person times the total number of persons
- Human population reduction
- More efficient use of resources
- Better management of our waste
- Better understanding of ecosystems
- The importance of human-dominated ecosystems and other types of ecosystems

Ecological Restoration

- Process of altering a site or area with the objective of reestablishing indigenous, historical ecosystems
- River restoration: Channel restoration, dam removal to reunite fragmented river ecosystems
- Beach and coastal sand dune restoration
- Reshaping the land, drainage, and vegetation patterns

Ecological Restoration Kissimmee River

- The process of altering a site or area to reestablish indigenous historical ecosystems
  - Prior to 1940, wide floodplain with diverse wetland plants, wading birds, waterfowl, fish, and other wildlife
  - 1942–1971: Two-thirds of the floodplain drained, degraded ecosystem functions and reduction of birds and fish population
  - 1992: Restoration project authorized by the Congress
  - 12 km straight channel restored to a meander

Ecological Restoration Everglades

- Since 1900, urban development, much of the Everglades drained
- One of the most valuable wetland ecosystem
  - 11,000 species of plants
  - 100s species of birds, fish, marine mammals
  - 70 threatened or endangered species
- Multi-level partnership restoration project
- Reduce pollution, remove invasive exotic species, and apply the precautionary principle
- Control human population, development, and access

Everglades Ecosystem

Figure 4.E1

(b)

Important Restoration Aspects

- Hydrologic process: surface water and ground water
- Soil and Rock: Geological conditions (rock and soil type, slope, landscape)
- Vegetation: The cover materials on land and wetland
- Socio-economic shareholders: Interests and start points
- Science: Restoration goals and endpoints

Restoration Process and Procedure

TABLE 4.1 Steps and Procedures in Planning and Initiating an Ecological Restoration Project

1.	Develop an ecological description of the area to be restored.
2.	Provide a clear understanding of the need for the restoration.
3.	Define the objectives and goals of the project.
4.	Specifically state the procedures that will be used to achieve the restoration.
5.	Clearly know the reference ecosystem that the restoration is attempting to reach.
6.	Determine how the restored ecosystem will be self-sustaining; that is, provide for flow of energy and cycling of chemicals to ensure long-term self-maintenance of the restored ecosystem and stable linkages to other ecosystems.
7.	State the standards of performance during restoration and monitoring following completion.
8.	Work with all people interested in the project (stakeholders) from initiation through completion and postproject monitoring.
9.	Examine what the potential consequences of the project are likely to be; that is, apply the principle of environmental unity, that everything affects everything else and anticipate what primary, secondary, and tertiary effects may be.

Modified after Society for Ecological Restoration, 2004. *The SER International Primer on Ecological Restoration*, www.SER.org.

Table 4.1

Biological Engineering in Ecologic Restoration

- Using vegetation in engineering projects to achieve specific ecological goals
- Designing and constructing certain ecosystems
- Modifying functions of ecosystems
  - Solarizing the ice plant of the sand dunes in Santa Barbara
  - Planting native dune vegetation species

Critical Thinking and Applied Questions

- An ecosystem consists of both living community and its nonliving environment. Is one of two components is more important?
- Based upon the linkage between ecology and geology, what is the importance of interdisciplinary collaborations in ecological restoration?
- What are the critical ecological challenges in your area?
- Are there any positive impact of land transformation on your local ecosystems?