

# APES Chapter 8 Outline: Community Ecology: Structure, Species Interactions, Succession & Sustainability

## 8-1 COMMUNITY STRUCTURE AND SPECIES DIVERSITY

### *A. Ecologists use three characteristics to describe a biological community.*

1. **Physical appearance:** the relative sizes, stratification, and distribution of its populations and species
  - a. Large terrestrial communities are patchy.
  - b. Transition occurs around the edges, where two community types interact.
  - c. Increased edge area may be harmful due to habitat fragmentation; many species become more vulnerable to predators and loss of colonization ability.
2. **Species diversity:** a combination of numbers of different species (richness) and abundance of individuals within each species (species evenness)
3. **Niche structure:** the number of ecological niches, their resemblance or difference from each other, and interaction of species with each other
  - a. High species richness often is correlated with low species evenness (few numbers per species).
  - b. Two major factors affect diversity of species in a community: latitude in terrestrial communities and pollution in aquatic systems.

### *B. The number of species on an island is determined by how fast new species arrive, how fast old species become extinct, the size of the island, and the distance from the mainland.*

1. The species equilibrium model, or the theory of island biogeography, was proposed in the 1960s to explain differences in species richness with island size.
  - a. Balance between two factors is important in this model: rate of immigration of species and rate of extinction of existing species.
  - b. Two island features are important: size and distance from mainland.
2. This model has been expanded to include habitat islands in protected areas such as national parks.

## 8-2 TYPES OF SPECIES Species in a community play many different roles in its ecology.

### *A. Types of Species*

1. Native species are those whose original home is in this particular ecosystem.
2. Nonnative species originally evolved in a different ecosystem and migrated or were introduced to a new ecosystem.
3. Indicator species alert us to harmful changes taking place in biological communities.
  - a. Birds are excellent biological indicators because they are everywhere and are quickly affected by environmental change.
  - b. Some amphibians are also considered indicator species.
    - 1) Disappearance may be a warning of serious declining environmental quality.

- 2) Vulnerability in different parts of an amphibian life cycle suggests degrees of environmental decline/disruption.
  - a) They are born and live in water and are prey to water-born pollutants.
  - b) As adults they live on land; they are unprotected because their skins readily absorb pollutants.
  - c) Frogs as a threatened species are harmed by habitat loss, drought, pollution, parasitism, disease, overhunting, ultraviolet radiation, etc.
4. The importance of amphibian species becoming extinct rests on three likelihoods.
  - a. This extinction suggests that the health of the environment is deteriorating.
  - b. Adult amphibians play important ecological roles in the world community.
    - 1) Extinction of one species leads to extinction of other species.
    - 2) Their biological niche controls insect populations.
  - c. They represent the possibility of hundreds of potential pharmaceutical products.

***B. Keystone species help ecological communities run smoothly; they determine the type and number of community species.***

1. Keystone species have a larger effect on both the types and number of other species in a community.
2. Keystone species fill important ecological roles: pollinating and regulating populations of other species.
3. Loss of a keystone species has far-reaching ramifications for other species in a community (for example, alligators).

***C. Foundation species shape communities by creating and enhancing habitat that benefits other species.***

1. Elephants, in breaking and uprooting trees, create forest openings in African savanna grasslands and woodlands.
2. Grazing species benefit from the new growth of grasses and other forage plants.
3. The rate of nutrient cycling is increased.

**8-3 SPECIES INTERACTIONS: COMPETITION AND PREDATION** Five basic species interactions are competition, predation, parasitism, mutualism, & commensalism.

***A. Competition between species for food, sunlight, water, soil, space, nest sites, etc. is interspecific competition.***

1. With intense competition for limited resources, one species must migrate, shift its feeding habits/behavior, or face extinction.
2. As humans take more and more space, other species are compromised.

**B. In competitive situations, some species evolve adaptations that reduce/avoid competition for resources.**

1. Over a long time, species evolve more specialized traits that allow them to use shared resources at different times or in different ways or in different places; this is termed resource partitioning. An example is that of insect-eating warblers in Maine forests that eat insects in specific parts of a spruce tree. Owls hunt at night; hawks hunt during the day.
2. Predator-prey relationships define one species (the predator) feeding/preying on another. Individually prey is harmed, but predation can help the population by eliminating the sick, weak, and old.
3. Predators have a variety of ways to capture prey. Herbivores feed on immobile plant species; carnivores use pursuit of prey or ambush to capture prey. Some predators use camouflage, and others use chemical warfare (venom) to capture prey or deter predators.
4. Prey species escape predators in a number of different ways, such as swift movement, protective shells, camouflage, or use of chemicals to repel or poison.

**8-4 SPP. INTERACTIONS: PARASITISM, MUTUALISM, & COMMENSALISM**

**A. Parasites live on or in another species. The host of this arrangement is obviously harmed by it, but the parasite can contribute to biodiversity by controlling the size of specific species populations.**

**B. Mutually beneficial interactions also exist in ecological environments.**

1. Mutualism is a relationship that benefits both species; these can be in dispersing pollen and seeds for reproduction, in receiving food, or in receiving protection.
2. Mutualism is not cooperation; each species exploits the other.
  - a. Birds, African buffalo, elephants, and rhinoceroses
  - b. Clownfish and anemones
  - c. Fungi and plant root associations called mycorrhizae

**C. Some species interaction helps one species but does nothing for the other; this is commensalism. Examples are the bromeliads & orchids (epiphytes).**

**8-5 ECOLOGICAL SUCCESSION: COMMUNITIES IN TRANSITION**

**A. With new environmental conditions, community structures can change; one group of species is replaced by another.**

1. **Ecological succession:** the gradual change in species composition of a given area.
2. **Primary ecological succession:** the gradual establishment of biotic communities on lifeless ground. In the soil, there is no terrestrial community; and in an aquatic community, there is no bottom sediment. Generally takes a very long time.
  - a. **Pioneer species** attach themselves to patches of bare rock to begin the process. Lichens and moss begin the building of soil particles.

- b. **Early successional plants:** tiny annuals that reseed, which are then followed by small perennial grasses, herbs, and ferns that grow close to the ground.
  - c. **Mid-successional plants** include low shrubs and trees that require more soil and lots of sunlight. This process takes hundreds of years.
  - d. **Late successional plant** species are generally tree species that create shade and can tolerate shade to become a complex forest community.
  - e. **Primary succession** can also take place in newly created small ponds that, over a long period of time, will be transformed to a marsh and finally to dry land.
3. *Secondary ecological succession* defines a series of communities with different species developing in places with soil or bottom sediment. The soil or sediment remains after the natural community of organisms has been disturbed, removed, or destroyed.
- a. Forest fires or deforestation, for example, can convert a particular stage of succession to an earlier stage.
  - b. Changes in vegetation during secondary succession also change the numbers and types of animals and decomposers.
4. **The classic view of ecological succession** is that it is an orderly sequence, each stage leading to the next, more stable stage until a climax community is reached. Such a community would represent the balance of nature, one dominated by a few long-lived plant species that are in balance with their environment. Three factors have been identified that affect how and at what rate succession occurs.
- a. **Facilitation:** an area made suitable for a 2<sup>nd</sup> species by the actions of the 1<sup>st</sup>
  - b. **Inhibition:** early species delay establishment of later species
  - c. **Tolerance:** later species are unaffected by plants at earlier stages of succession
5. Disturbances such as fire, drought, mining, plowing, climate change, etc. can set back succession to an earlier stage.
- a. **Large catastrophic disturbances** can devastate a community, but in the long run, they create unfilled niches and may encourage greater biodiversity.
  - b. **The intermediate disturbance hypothesis** contends that infrequent, moderate disturbances are large enough to create openings for colonizing species, but mild enough for the survival of some mature species in undisturbed areas. There is some evidence to support this hypothesis, but not enough to state that this applies to all types of communities.
6. Scientists can't predict the course of a given succession in a community toward a stable climax community in balance with its environment.
- a. The equilibrium model of succession was thought of as the balance of nature.
  - b. Ecologists now view a community as a continuous change, with instability rather than equilibrium.
  - c. Succession: a struggle for each species to obtain food, light, nutrients, & space to gain an advantage by occupying as much of its fundamental niche as possible.
  - d. The term biotic change better describes the changes occurring than does succession, and mature community fits better than climax community when describing a relatively stable community with a mosaic of vegetation patches.

## 8-6 ECOLOGICAL STABILITY, COMPLEXITY, AND SUSTAINABILITY

Living systems maintain some degree of stability or sustainability through constant change in response to changing environmental conditions.

*A. All systems, from the smallest to the largest, are constantly changing in response to changing environmental conditions. There are a series of positive and negative loops that interact to provide stability or sustainability over the life span of a system. There are three aspects of stability or sustainability in living systems.*

1. A system that resists being disturbed or altered is said to have persistence or inertia.
2. A population that can keep its numbers within limits imposed by the resources shows constancy.
3. A system that is able to repair damage after a moderate external disturbance shows resilience.

*B. Some communities obtain ecological stability or sustainability by having many different species present.*

1. One measure of a community's biodiversity is to consider the complexity, or number of species present, at each trophic level of the community. Exceptions to this view of stability have been found.
2. There is a minimum threshold of species diversity, since no community can survive without some producers and decomposers.
3. Recent research indicates that communities with more species tend to have a higher net primary productivity
4. How much biodiversity is needed to maintain stability is still being debated. Part of the problem lies in the disagreement on how to define stability.
5. Populations, communities, and ecosystems are rarely in a state of equilibrium.

*C. We should take precautionary measures to prevent serious harm even if some of the cause-and-effect relationships have not been established.*

1. Some developers feel there is no good reason to maintain biological diversity if it does not necessarily lead to ecological stability.
2. Ecologists point out that environmental degradation is and has been occurring due to human disturbances. This has disrupted some of the environmental services that support and sustain all life and all economies.
  - a. The wise course is to use caution regarding the making of potentially harmful changes to communities and ecosystems.
  - b. The precautionary principle can be taken too far. Some risk is necessary in order to discover what works and what doesn't. We must consider possible short- and long-term expected and unintended effects.
  - c. Interactions of organisms in a community determine their abundance and distributions and serve as natural selection on one another through coevolution.