44 Ecological Communities

Chapter Outline

Chapter 44 examines how multiple groups of species interact to form communities. Communities change as the environment changes, with latitude or elevation, and with other factors, such as extinction and colonization, disturbance, and climate change. When disturbances occur in ecosystems, there will likely be changes in the affected communities. Depending on the severity of the disturbance, the original community may or may not return to its native state. Catastrophic disturbances, such as volcanic eruptions, can create entirely new landscapes for colonization by new communities. On a smaller scale, the local extinction of one species may open a window for a small change in community structure.

Energy and materials move within and through communities. Solar energy enters communities as a readily usable, high-energy input, with one output: heat. Thus, energy flows through an ecological community in a one-way direction. Matter, on the other hand, is continuously recycled within the community as organisms consume other organisms, die, and decompose, thereby releasing primary nutrients needed by others in the community. In fact, many of the molecules in your body were not too long ago in an autotroph, maybe in a kernel of corn or a leaf of lettuce. Ultimately, the molecules and atoms that comprise our bodies have been recycled millions of times, as matter is neither created nor destroyed, per the laws of thermodynamics. To put these phenomena succinctly: energy flows and matter cycles.

Estimating biodiversity in an ecological community provides an indication of its health and stability. Biodiversity is measured by both species richness and species evenness. Species richness is simply how many species are in a community. Species evenness is less intuitive; it focuses on how many of each species are present and how individual organisms are spatially distributed in the community. As biodiversity increases, the productivity and stability of a community generally increase, as well.

Humans depend on many ecosystem services provided by different organisms or groups of organisms. For example, pollinators are critical to many forms of agriculture. Without them, many crops will fail to form their fruits or vegetables. Managing and restoring ecosystems while maintaining their health are key facets of research and practice in community ecology.

Chapter 44 spans **Big Idea 1**, **Big Idea 2**, and **Big Idea 4** and looks at how evolution ties in with ecology. The specific parts of the AP Biology curriculum covering **Big Idea 1:** The process of evolution drives the diversity and unity of life, include:

- **1.C.1**: Speciation and extinction have occurred throughout the Earth's history.

The specific parts covering **Big Idea 2:** Biological systems utilize free energy and molecular building blocks to grow, to reproduce, and to maintain dynamic homeostasis, include:

- **2.A.1**: All living systems require constant input of free energy.
- **2.A.2**: Organisms capture and store free energy for use in biological processes.
- **2.D.1**: All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
- **2.D.3**: Biological systems are affected by disruptions to their dynamic homeostasis.

The specific parts addressing **Big Idea 4:** Biological systems interact, and these systems and their interactions possess complex properties, include:

- **4.A.5**: Communities are composed of populations of organisms that interact in complex ways.
- **4.A.6**: Interactions among living systems and with their environment result in the movement of matter and energy.
- **4.B.3**: Interactions between and within populations influence patterns of species distribution and abundance.
- **4.B.4**: Distribution of local and global ecosystems changes over time.
- **4.C.4**: The diversity of species within an ecosystem may influence the stability of the ecosystem.

Chapter Review

Concept 44.1 *states that communities are made up of groups of species that coexist and interact with one another within a defined geographic area. The boundaries of some communities are determined by the physical habitat: a pond, for example, defines a community of aquatic species that interact much more with one another than with terrestrial species outside the pond. However, the boundaries between different communities often overlap. For example, raccoons from a forest community will forage for food at a pond's edge, while deer will graze on grass in an open meadow and retreat into the forest for protection. Thus, an ecosystem's boundaries are flexible.*

1. Ecotones are transitional boundaries between ecosystems, such as the border between a grassy area and a forest. This area has a mixture of grasses, shrubs, small trees, and older trees all living in a thin strip. Identify another ecotone and describe the characteristics of the two ecosystems bordering it. Explain how the area includes features of each bordering community.

2. Despite the many decades that have passed since the eruption of the volcano on the Indonesian island of Krakatoa, stable communities of organisms are only now becoming established on the island. Explain why these communities are not identical to the communities present when the volcano erupted in 1883.

3. The new communities on Krakatoa appear to be stabilizing. Discuss whether or not these communities will continue to be stable or change in the future.

Concept 44.2 *examines how communities of organisms change over time. Succession is most dramatic in a community after a major disturbance and is a somewhat predictable progression of species coming and going. In rare circumstances, a new community forms where there are very few preexisting species and little to no soil, such as a lava flow, or a boulder field left by a retreating glacier. Most successional events occur as one population or community replaces another. This is called secondary succession. Climate change, invasive species, and humans are all causes of disturbances that lead to succession.*

4. Recall that free energy is the energy available for use in an ecosystem. Explain how changes in free energy availability can disrupt an ecosystem. Give three examples of possible disruptions, and describe their effects on energy availability. Be sure your examples include a disruption that increases free energy and one that decreases it.

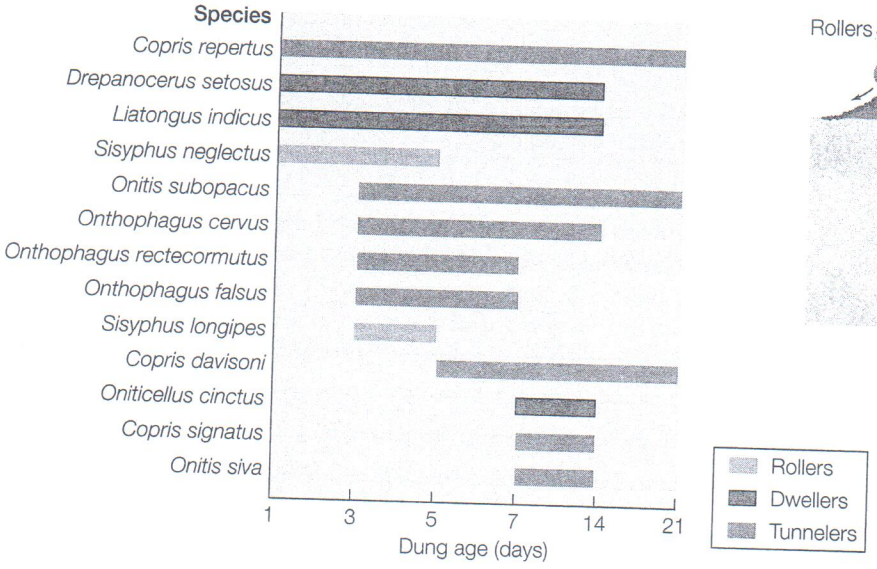
5. For each disruption in Question 4, discuss what effect each departure from preexisting conditions will have on the number and size of trophic levels.

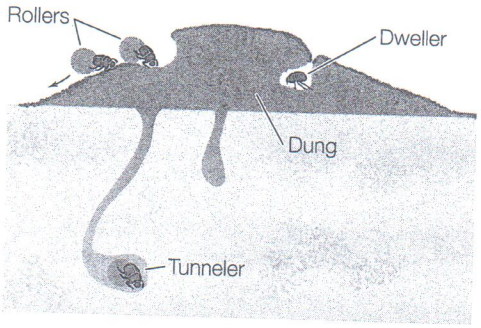
6. Explain how changes in the number of producers, such as reductions caused by disease outbreaks, can affect the number and size of other trophic levels.

Concept 44.3 *describes how energy and matter move through an ecosystem. Remember, energy flows through an ecosystem, and matter is constantly recycled. Autotrophs use solar energy to synthesize chemicals that have potential energy. As consumers eat autotrophs, they utilize this energy for metabolism and store some of the chemicals for future use. A good rule of thumb is the 10 percent rule: the total biomass of each trophic level is about one-tenth that of the level it feeds on.*

7. Identify two examples of free energy in the environment that autotrophs can utilize, and explain how each is used.

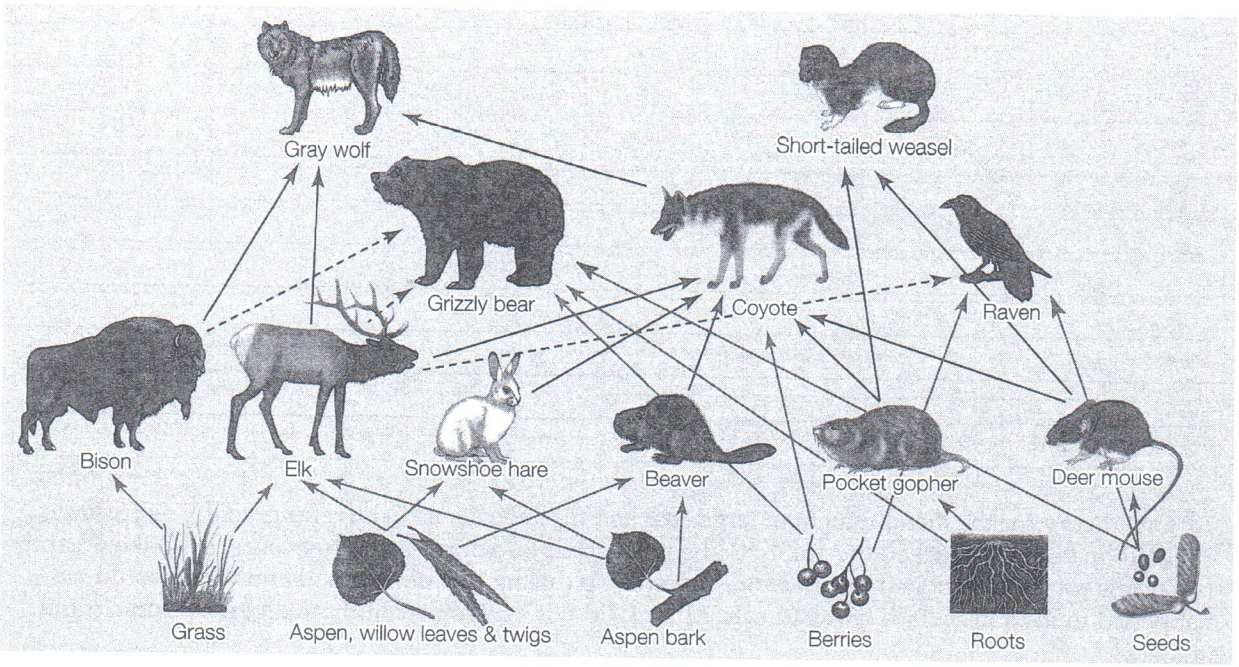
8. Dung beetles utilize dung in many ways. Some eat dung, others lay their eggs in it, and some form balls of dung and roll them into their nests. The graph shows how the species composition of dung beetles changes in a pile of dung over time. Describe this process with regard to rollers, dwellers, and tunnelers.





9. Frequently, after disturbances like a fire or a tree falling, an ecosystem will go through a predictable ecological succession of changes. Explain why the succession does not always restore the original community.

Refer to the figure below to answer Questions 10–12. The figure shows a food web for species in the grasslands of Yellowstone National Park.



10. Briefly describe what would happen if each of the following groups were removed from the park. Limit your answer to two trophic levels.

a. Coyotes: _____

_____

_____

b. All primary producers: _____

_____

_____

c. All consumers: _____

_____

_____

11. Discuss two possible consequences of adding to Yellowstone Park a new primary consumer that feeds only on grasses.

_____

_____

_____

_____

_____

_____

_____

_____

_____

12. Explain why there are fewer high-level consumers (wolves and weasels) than primary consumers in Yellowstone National Park.

13. One theory for the development of large coal and oil deposits is that the fungi that lived prior to 300 million years ago lacked the ability to digest the cellulose of trees and tree ferns. Describe what the landscape must have looked like in a forest or swamp during this time period and what would have happened to the soil surface of the forests if fungi did not evolve the ability to digest cellulose more quickly.

14. Explain how each of the following abiotic factors can affect the stability of populations.

a. Water:

b. Nutrient availability:

c. Availability of nesting materials and sites:

15. Explain how each of the following biotic factors can affect the stability of populations.

a. Food chains and food webs: _____

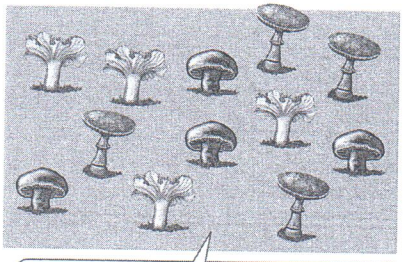
b. Species diversity: _____

c. Population density: _____

d. Algal blooms: _____

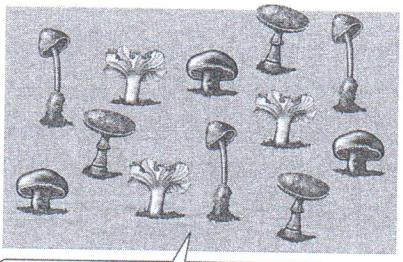
16. The hypothetical communities of fungi pictured below have 12 individuals each, but they but differ in species richness and relative abundance, both of which affect diversity. Describe where you might find an example of each of these communities in the real world. (Your examples do not need to be limited to just three or four species.)

Community A



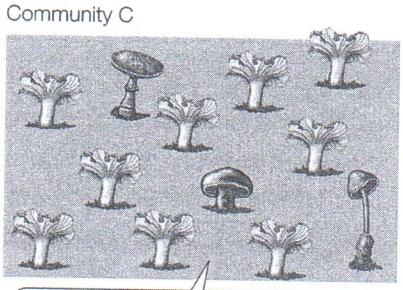
Community A is less diverse than community B because it contains three equally abundant species rather than four.

Community B



With four equally abundant species, community B is the most diverse.

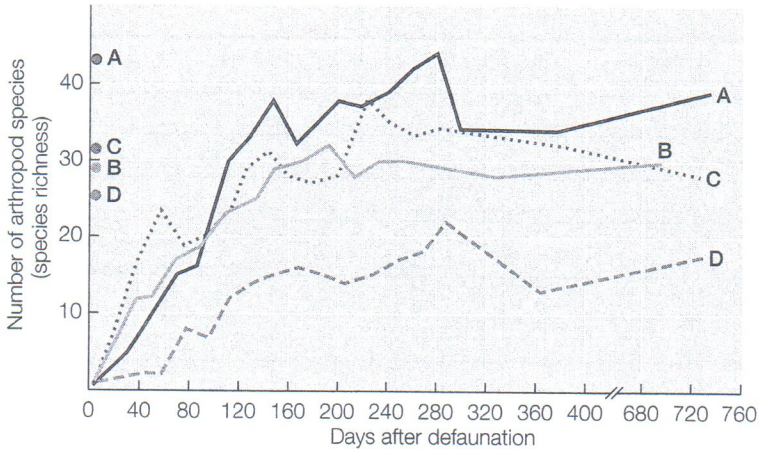
Community C



Community C is less diverse than community B because it has an uneven distribution of the four species.

Concept 44.4 *discusses some of the factors that influence biodiversity. The study of island biogeography has contributed greatly to our understanding of biodiversity and the structure and function of ecological communities. Islands often have simpler food webs than those found on larger land masses.*

17. By the experimental removal of all arthropods (defaunation) from four mangrove islands of equal size but different distances from the mainland, two researchers were able to observe the process of recolonization. They compared the results by using the predictions of the theory of island biogeography. Below is a graph of their data.



a. Which line would represent an island closest to the mainland? Explain.

b. Why do most of the lines level off after approximately 200 days?

c. The dots on the left of the graph represent original numbers of arthropod species present on each island. Explain why the recolonization populations are similar to but not the same as the original populations.

18. Propose and explain the likely relationship between increased biodiversity and increased stability in ecosystems.

19. Choose two of the disruptions below, and discuss how their human impacts accelerate change at local and global levels. Identify specific organisms, and describe the effects of the disruption on those organisms.

- Logging
- Slash-and-burn agriculture
- Urbanization
- Monocropping
- Infrastructure development (dams, transmission lines, roads)

20. Choose one item from the list below, and discuss how introduced species can exploit new niches free of predators or competitors while devastating native species.

- Dutch elm disease
- Potato blight
- Smallpox [historic example for Native Americans]

Concept 44.5 *explores the value of maintaining and fostering the biodiversity of communities. The demise of many thousands of beehives due to colony collapse disorder has caused alarm. Colony collapse disorder is thought to be a complex interaction among multiple variables, possibly including a fungus and protozoans, but why it happens and where it came from is still a puzzle.*

21. Some ecologists propose buying land in Central America and forming a green belt of vegetation from South America through tropical America. Others propose saving large isolated regions as parks. Discuss which proposal would be more successful for maintaining species biodiversity throughout Central America.

Science Practices & Inquiry

In the AP Biology Curriculum Framework, there are seven **Science Practices**. In this chapter, we focus on **Science Practice 6**: The student can work with scientific explanations and theories. More specifically, we focus on **Science Practice 6.4:** The student can make claims and predictions about natural phenomena based on scientific theories and models.

Question 22 asks you to make scientific claims and predictions about how species diversity within an ecosystem influences ecosystem stability (**Learning Objective 4.27**).

22. Species diversity is impacted by many different phenomena. Choose three of the disruptions below, and explain how each can impact the dynamic homeostasis or balance of an ecosystem.

- Invasive and/or eruptive species
- Human impact
- Hurricanes, floods, earthquakes, volcanoes, fires
- Water limitation
- Increased salinity