Chapter 18

Ecosystems

18.5 Ecological Succession

In 1883, a huge volcanic explosion tore through the tropical island of Krakatoa. Most of the island was destroyed. The fragment that remained was covered with ash, barren and lifeless. But within three years, a few living organisms, primarily photosynthetic bacteria and ferns, had colonized the island. By 1897, Krakatoa had become a savanna covered with tall grasses. Only a few species of animals were present—almost all of these were flying insects and birds. By 1919, scattered trees could be seen, and by 1931, a forest had developed. As more trees grew, animal diversity increased. Today, Krakatoa is once again tropical forest.

Krakatoa's history provides an example of ecological succession. **Ecological succession** describes how the community of species living in an ecosystem changes over time. There are two kinds of ecological succession: primary succession and secondary succession.

Primary succession occurs when bare land, devoid of soil, is colonized by successive waves of living organisms. For example, primary succession may begin when new land is formed by volcanic activity, or when a glacier's retreat reveals bare rock.

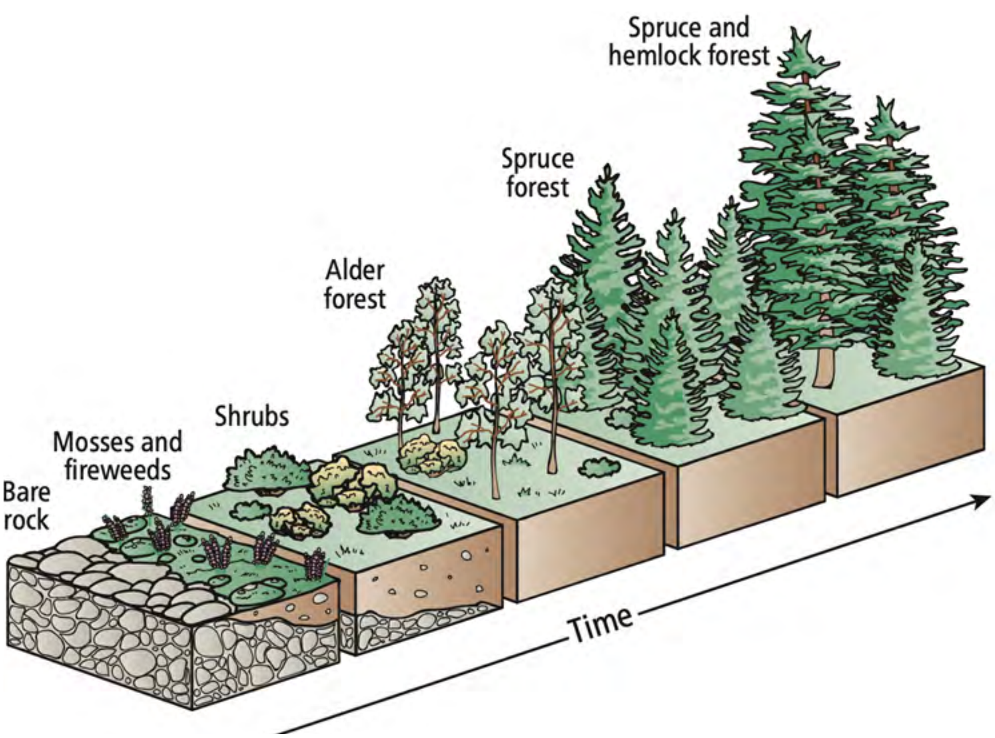


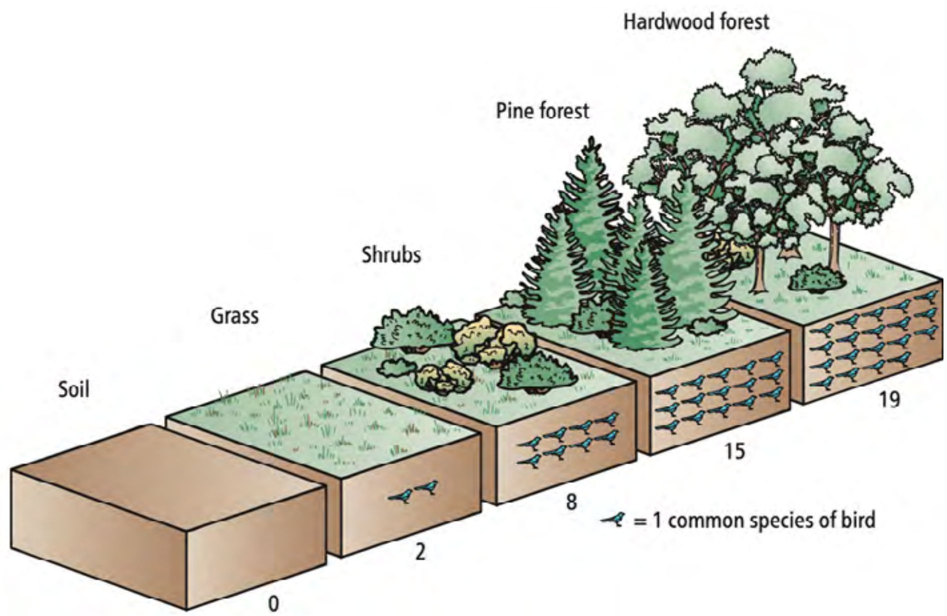
FIGURE 18.15

Primary succession after a glacier's retreat in Alaska: Bare rock was covered by mosses and fireweeds, then shrubs, an alder forest, a spruce forest, and finally a spruce and hemlock forest. The entire process took place over about 200 years.

The first species to colonize bare land are known as *pioneer species*. Pioneer species often include photosynthetic microorganisms as well as larger organisms such as lichens and mosses. Pioneer species must be able to survive with few nutrients and little existing organic matter. They also must be able to deal with direct sunlight and the variable temperatures that result from lack of cover. Pioneer species may be succeeded by grasses, shrubs, and finally trees. At each stage of succession, the activities of earlier waves of colonizers build up nutrients and organic matter, allowing later colonizers to thrive. Later colonizers eventually outcompete and displace earlier colonizers. Ecological succession ends with a **climax community** that is relatively stable (Figure 18.15). During the process of succession, the total biomass of the ecosystem typically increases, as does the number of species present.

FIGURE 18.16

In secondary succession on abandoned farmland in the southeastern United States, empty fields progressed from grassland to shrubland, pine forest, and hardwood forest over the course of more than 100 years. Greater biodiversity—for example, more species of birds—was seen as succession progressed.



Secondary succession occurs when a disturbance destroys existing life in a habitat but leaves the soil intact. Secondary succession may begin after a fire or when old farmland is abandoned. Because soil is already present, secondary succession proceeds more quickly than primary succession. As with primary succession, biomass and biodiversity typically increase as secondary succession progresses. For example, during secondary succession on abandoned farmland in the southeastern United States, the number of bird species increased as succession progressed (Figure 18.16).

All ecosystems experience change. Most ecosystems never suffer a cataclysm like Krakatoa's, but smaller disturbances, often affecting only a small area of habitat, are common. Fires, floods, and other natural events all damage habitats. Even the fall of a large tree can be a disturbance with significant consequences. In tropical forests, for example, tree falls create holes in the canopy that make sunlight—a rare commodity—suddenly available to organisms in the understory.

According to the *intermediate disturbance hypothesis*, regular disturbances can actually contribute to biodiversity, as long as they are not too extreme. This is because an intermediate level of disturbance guarantees that there will always be habitat at varying stages of recovery, and different species make use of these different habitats. Of course, some disturbances have more lasting effects. Invasive species can devastate ecosystems, as we saw with the brown tree snake in Guam and the zebra mussel in the eastern United States. Human activity can convert one type of ecosystem into another, as when land is cleared for agriculture or for development. Finally, changes in climate, including global warming, can bring big changes to many ecosystems at the same time.

READING CHECK

How might global warming cause ecosystems to change?

CHECK YOUR ANSWER

This is a difficult question that many scientists are trying to answer. As Earth gets warmer, entire ecosystems are likely to shift to areas that have more appropriate climates. Usually, this means higher latitudes (locations farther away from the equator) and higher elevations. However, many organisms have no appropriate habitat to shift to. For example, polar bears already live in the Arctic and cannot search for sea ice farther north. In addition, large areas of Earth have already been developed for human use. Even if there is appropriate new habitat somewhere on a warmer Earth, there may be no way for most organisms to move through human cities or farms to reach it.

To read more about ecological succession, visit the following website:

http://www.countrysideinfo.co.uk/successn/index.htm