4.2

# Ecosystem Dynamics

Lava flow from a volcanic eruption can change an ecosystem dramatically.

## CAN YOU EXPLAIN IT?

**Gather Evidence** As you explore the lesson, gather evidence for how ecosystems maintain stability over time.

**FIGURE 1:** A young plant grows in a crack in a sheet of bare volcanic rock.

Molten lava flowing from a volcano burns everything in its path. When it cools, a layer of solid rock is left behind. However, over time, a new ecosystem will become established on this seemingly lifeless landscape.

**Predict** How do you think an ecosystem can be reestablished in an area after a disturbance such as a volcano?

# Interactions in Ecosystems

The ways in which flamingos interact with other organisms and their environment are only a small part of the ecology of a tropical lagoon ecosystem. To understand what individuals, populations, and communities need to survive, ecologists study the interactions among and between species and their environment.

**FIGURE 2:** Flamingos live and feed in large groups.

## Habitat and Niche

Flamingos live in tropical and subtropical regions of the world. They prefer environments that have alkaline lakes or saltwater lagoons and large mud flats. These environmental features are examples of a flamingo's habitat. A habitat includes all of the biotic and abiotic factors in the environment where an organism lives. For a flamingo, these factors include things such as the shrimp and other small invertebrates that it eats, the water salinity, and the air temperature.

**Model** Draw a model of your habitat. Think of all the places that you regularly visit and the people you interact with, and include those in your model.

Many species live in the same habitat, but each species occupies a different ecological niche. An ecological niche contains all the physical, chemical, and biological factors that a species needs to survive and reproduce.

The factors that make up a species' niche include the following:

**Explain** How is a niche different from a habitat?

**Food sources** The type of food a species eats, how a species competes with others for food, and where it fits in the food web are all part of a species' niche.

**Abiotic conditions** A niche includes the range of conditions such as air temperature and amount of water that a species can tolerate.

**Behavior** The time of day a species is active and where and when it feeds and reproduces also are factors in the niche of a species.

An ecosystem is a collection of habitats. The organisms that occupy these habitats have separate niches, but the niches have certain abiotic and biotic factors in common. Think of a habitat as *where* a species lives and a niche as *how* the species lives within its habitat.

## Relationships in Ecosystems

Each organism in an ecosystem interacts with other organisms as it goes about its daily activities. The flamingos and other animals prey on the lagoon's plankton, invertebrate, and fish populations for food, and they in turn are food for larger carnivores. Plants compete with one another for space, water, and nutrients. Still other organisms form interspecies relationships to provide or gain shelter, get protection, or find food. These interspecies interactions often benefit only one of the organisms in the relationship, but sometimes both organisms benefit.

**FIGURE 3:** The frog is the predator in this relationship.

## Predation and Competition

Predation is the process by which one organism, the predator, captures and feeds upon another organism, the prey. The frog in Figure 3 is the predator, and the insect is its prey. However, if a snake slithered by, the frog might become its prey. Predation is not limited to carnivores—herbivores that seek out and eat parts of living plants are considered predators, too. The relationship between predator and prey is important for energy transfer in food chains.

**Analyze** Are humans predators in their ecosystem? Explain your answer.

Competition occurs when two organisms compete for the same limited resource, be it food, shelter, water, space, or any other biotic or abiotic factor that both organisms need to survive. Whenever two organisms need the same resource in a habitat, they must compete for it. Competition can occur between members of different species or between members of the same species, such as the blue jays that are fighting over a peanut in Figure 4.

**FIGURE 4:** Two blue jays compete for a food source.

**Collaborate** With a partner, think of at least two reasons why an organism might compete with another organism of the same species for a limited resource. Explain why two organisms would compete for these limited resources rather than share them.

Competition for limited resources in an ecosystem can be like a game of musical chairs—not enough chairs are available for everyone and each chair seats only one person. When the music stops, one person will be competitively blocked from the chairs by the remaining players.

## Stability and Change

**FIGURE 5:** These songbirds eat insects commonly found in spruce, pine, and fir trees.


In ecology, the principle of competitive exclusion states that when two species compete for the same resources, one species will be better able to get the resources in the niche. The unsuccessful species will be pushed into another niche or become extinct. The result is that both species end up in distinctive niches so they do not compete for the same limited resource.

**Analyze** Use the diagram in Figure 5 to answer the following questions.

1. What does this diagram show, and how does it relate to the competitive exclusion principle?
2. Suppose the tip of the spruce tree was broken off during a wind storm. How might the birds be affected by the loss of the uppermost niche in the tree?

## Symbiosis

Symbiosis is a close ecological relationship between two or more organisms of different species that live in direct contact with one another. There are three major types of symbiosis: mutualism, commensalism, and parasitism.

**FIGURE 6:** Symbiotic relationships

**Mutualism**
Mutualism occurs when both species benefit from the relationship. Pollination, in which an insect pollinates a plant, is a common example of mutualism. Other examples of mutualism include species providing food or shelter, aiding in reproduction, or providing protection for one another. A shrimp cleaning the mouth of a fish, shown at left, is an example of mutualism.

**Commensalism**
Commensalism is a relationship between two organisms in which one organism receives an ecological benefit from the other, while the other neither benefits nor is harmed. A commensal relationship between two species might involve one organism providing transportation or a home for the other without harm or benefit to itself. As shown at left, an egret eating the insects stirred up by a cow as it moves and feeds on grass is an example of commensalism. The cow neither benefits nor is harmed by the actions of the egret.

**Parasitism**
Parasitism is a relationship in which one of the organisms benefits while the other one is harmed. Unlike a predator, which kills and eats its prey, a parasite benefits by keeping its host alive for days or even years. The needs of the parasite are met by the victim of the parasite, called the host. The host's health often suffers due to blood or nutrient loss. Galls made by insects on the leaves of plants are an example of parasitism, as shown here.

**Gather Evidence**
What do the shrimp and the fish each gain from this ecological relationship? Why doesn't the fish eat the shrimp?

**Explain** How might symbiosis help the stability of an ecosystem? How might it hurt ecosystem stability?

# Biodiversity in Ecosystems

**FIGURE 7:** Coral reefs are marine ecosystems where many different species live.

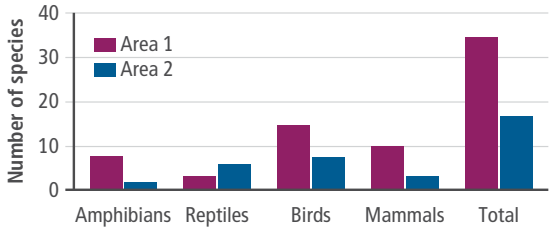
Coral reefs make up a small percentage of marine habitats, but contain most of the oceans' species diversity. The more diverse an ecosystem is, the more likely it is to remain stable over the long term. If a disturbance, such as pollution or a fire, affects an ecosystem, recovery can happen more quickly if that ecosystem has more biodiversity.

## Biodiversity

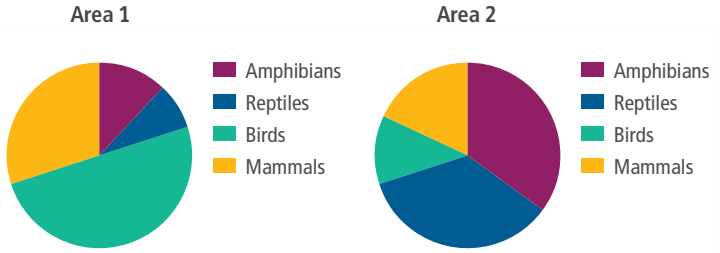
The complexity of an ecosystem indicates its biodiversity level. Biodiversity refers to the variety of species within an ecosystem. Note that biodiversity measures the number of different species, not the number of individual organisms living in an area. An area with a high level of biodiversity, such as a coral reef, has a large assortment of species living near one another. Biodiversity depends on many factors, such as moisture and temperature. The complex relationships in ecosystems mean that a change in a single biotic or abiotic factor can have a variety of effects, both small and large, on many different species.

## Data Analysis

**FIGURE 8:** Ecologists analyze species richness (left) and species evenness (right) to evaluate ecosystem biodiversity.




a Species richness




b Species evenness

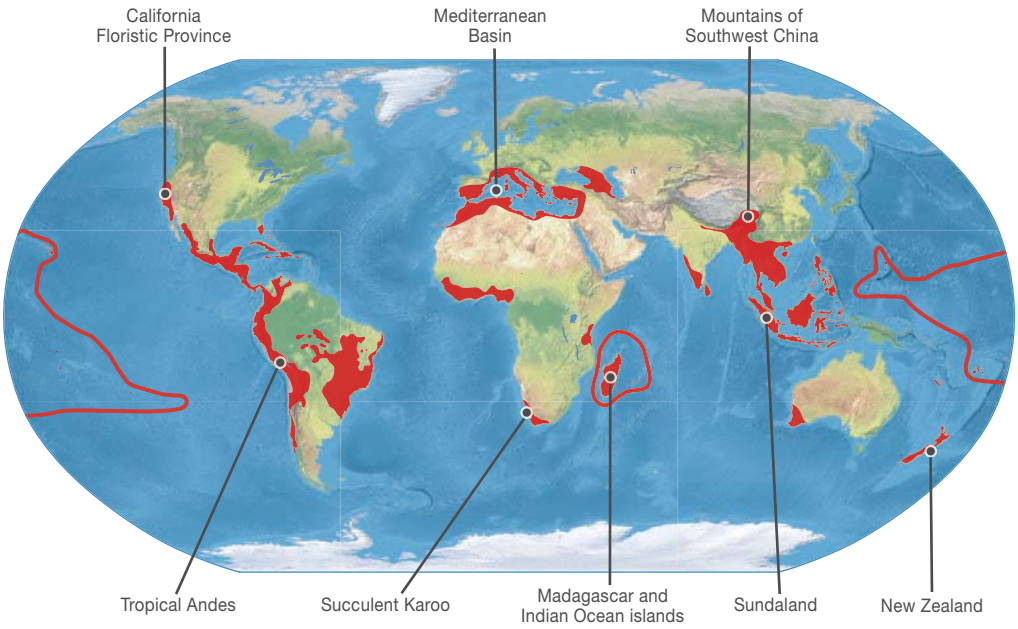
There are many different ways to measure biodiversity in an area. Two factors that ecologists often use are species richness and species evenness. Species richness is the number of species per sample of an area. Areas with a high number of different species have high species richness and therefore high biodiversity. Species evenness measures the abundance of different species that make up the species richness. Species evenness considers the relative distribution of the numbers of species in an ecosystem.

**Explain** Use the graphs in Figure 8 to answer the following questions:

1. What might happen if a new bird species arrived in Area 1?
2. How could this affect the species richness and species evenness in Area 1?
3. What conclusions can you draw about species richness and species evenness between the two areas?

**FIGURE 9:** Scientists have identified over 30 biodiversity hot spots around the world.

Explore Online




A biodiversity hot spot is an area with a particularly high level of biodiversity. Figure 9 shows a global map of biodiversity hot spots. These locations often contain species that are found nowhere else in the world. One hot spot located in North America is the California Floristic Province, an area with a Mediterranean-like climate that is home to giant sequoia and coastal redwood trees.

Scientists are currently working to protect several biodiversity hot spots. Preserving these areas helps to prevent species from going extinct and protects the ecosystem as a whole. Maintaining as much biodiversity as possible makes the entire biosphere healthier and provides a more stable habitat for plants, animals, and other species. These areas also are important, because they may hold clues to new medicines and new resources and may further our understanding of the biosphere.

**Analyze** Biodiversity hot spots are found around the world. Why can scientists not come up with a single solution to protect all of these areas?

## Engineering

# Building Artificial Coral Reefs

Earth's coral reefs are critical for the stability of marine ecosystems. Unfortunately, many are classified as threatened because of the effects of human activity. Living corals depend on the limestone deposited by their predecessors to get the minerals necessary to build their own bodies. However, the limestone is being dissolved from existing reefs due to increased ocean acidity caused by climate change. Marine ecologists are now combating this destruction by sinking artificial reefs, such as the one shown in Figure 10, which uses electrical currents to attract the limestone deposits needed by growing coral.

**Gather Evidence** What is the relationship between biodiversity and ecosystem stability? How do artificial reefs affect a marine ecosystem's stability?

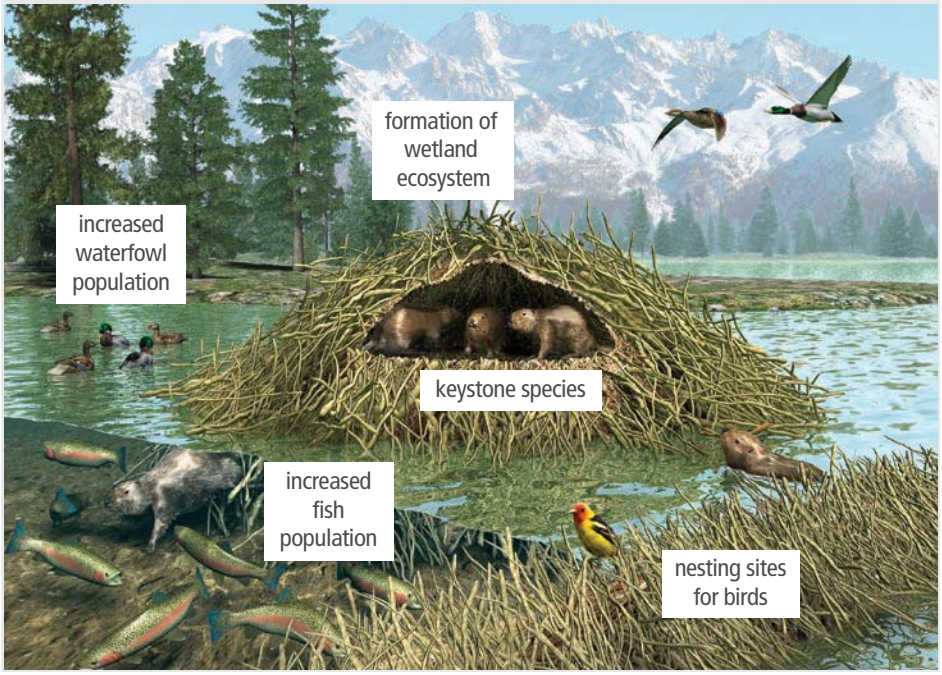
**FIGURE 10:** Artificial reef

## Keystone Species

Sometimes a single species has an especially strong effect on an entire ecosystem. This species is called a keystone species. Whatever happens to this species affects all the other species in that ecosystem. For example, when the beavers shown in Figure 11 built their dam across a stream, it turned a terrestrial ecosystem into a freshwater ecosystem. This killed existing plants and forced land animals to move to new territories. The new pond's inhabitants rely on the beavers to maintain the dam. If the beavers are removed, the dam will eventually fail. The pond will drain and over time the land will return to a terrestrial ecosystem, such as a meadow.

**Collaborate** With a partner, discuss why protecting a keystone species can protect a habitat as a whole.

**FIGURE 11:** Beavers are a keystone species that make and maintain pond ecosystems.




## Factors That Affect Biodiversity

Many factors can reduce biodiversity. Human activities can reduce it very quickly. Humans need food, and much of that food comes from plants, which requires large areas of land to be cleared to make fields to grow crops. Developing agricultural land removes most of the native plant and animal species in a region and replaces them with one or only a few species that are managed as crops. In addition, pesticide use can negatively affect any remaining native organisms. Biodiversity also is lost when land is cleared for human housing and industrial sites.

**FIGURE 12:** Many farmers use pesticides to control insects and weeds to increase the amount of harvested crops.

Introduction of new plants and animals into ecosystems is another serious issue. These species can reduce biodiversity by preying on native species or outcompeting native species for resources, such as food or shelter.

**Explain** How does a natural phenomenon, such as the eruption of a volcano on an oceanic island, affect biodiversity? Will the biodiversity that returns to the island be the same as it was before?

# Disturbances in Ecosystems

An ecosystem is a complex web of relationships and interactions among organisms in their environment. In general, an ecosystem can remain relatively constant over a long time under stable conditions. However, a change in one or more of the biotic or abiotic factors can disrupt the ecosystem and cause change. A change brought about by a physical, chemical, or biological agent that impacts population size or community structure is called a *disturbance*. Disturbances can occur over short or long time frames. The type and size of the disturbance can affect how the ecosystem changes. For example, a tsunami wave rapidly disrupts a coastal ecosystem by flooding habitats and saturating soil with salt.

**FIGURE 13:** A tsunami causes devastating flooding.

**Analyze** How might the carrying capacity of a coastal ecosystem change as the result of a tsunami? Explain using one or more examples.

## Natural Disturbances

Natural disturbances refer to the damage or destruction to ecosystems caused by nature. Tornadoes, volcanic eruptions, and lightning-caused forest fires are all examples of natural disturbances. These disturbances may affect only a small area. For example, a tornado causes a natural disturbance in a relatively narrow path where it touches down, while a forest fire or flood can cause natural disturbances that cover many square miles.

## Human-Caused Disturbances

People live in the environment, and many of our actions affect ecosystems. Human-caused disturbances include human settlements, agriculture, air and water pollution, clear-cutting forests, and mining. Like natural disturbances, human-caused disturbances can affect both small and large areas. They destroy habitats, wipe out producers, and contribute to a loss of biodiversity. However, some disturbances are unique to humans, because the changes are more or less permanent. For example, roads and highways can permanently fragment an ecosystem, changing the way populations of species interact with their habitat and altering the way abiotic factors cycle through an ecosystem.

**FIGURE 14:** Clear-cutting a forest means removing all the trees.

**Collaborate** With a partner, discuss why foresters might choose to clear-cut a forest rather than use another method to get wood for human needs. What are the pros and cons of clear-cutting?

## Ecosystem Stability

Disturbances alter ecosystems, but if an ecosystem is relatively stable over time, it can usually recover from a disturbance at a faster rate, adapting to or reversing any changes. How well an ecosystem rebounds, however, is determined by two factors: its resilience and its resistance.

Explore Online

**Language Arts Connection**

**The Key(stone) to Ecosystem Stability** Prepare a presentation describing the effects that your chosen keystone species has on ecosystem stability.

**FIGURE 15:** This old-growth forest has been stable for many years.

**Analyze** Old-growth forests have remained undisturbed for hundreds of years or more. From what you see in Figure 15, what are some characteristics of a stable ecosystem?

## Ecosystem Resilience

Explore Online

Hands-On Activity

**Simulating Fire in a Forest Ecosystem** Develop or use an already-existing simulation to examine how fire affects forest species. How might prescribed burns be used to manage the biodiversity in a forest, including threatened or endangered species?

Ecologists define ecosystem resilience as the ability of an ecosystem to recover after it has undergone a disturbance. This means that even though the structure of the ecosystem is affected in some way, the ecosystem can recover quickly and return to functioning as it did before the disturbance. For example, a grassland that has regular fires is considered resilient, because the grasses quickly regrow and the animals return very soon after a fire ends.

The resilience of an ecosystem is determined in part by its level of biodiversity. A complex ecosystem with many populations of species that perform the same function, such as producers, is more resilient than one that has a limited number of species that perform each function. Consider two forests—one a single-species stand of mature pine trees and the other a multispecies stand of old and young conifers. If both stands are impacted by identical severe wind events, the stand of mature pines will be more severely affected by breakage and uprooting than the mixed stand. The mixed stand, with its variety of wood characteristics and ages, will have more trees left after the wind event. It will recover and continue to function as a forest much more quickly than the singles-species stand of pines.

Biodiversity improves the resilience of an ecosystem, but only to a point. Genetic diversity in each species in an ecosystem is also important. Human activities that alter biodiversity or increase the rate of change, such as using pesticides and antibiotics, fishing, and destroying rain forests, reduce genetic diversity. A reduction in genetic diversity decreases the chance that populations can adapt to abiotic disturbances in an ecosystem.

**Predict** What similarities would you expect to find in a highly resilient ecosystem?

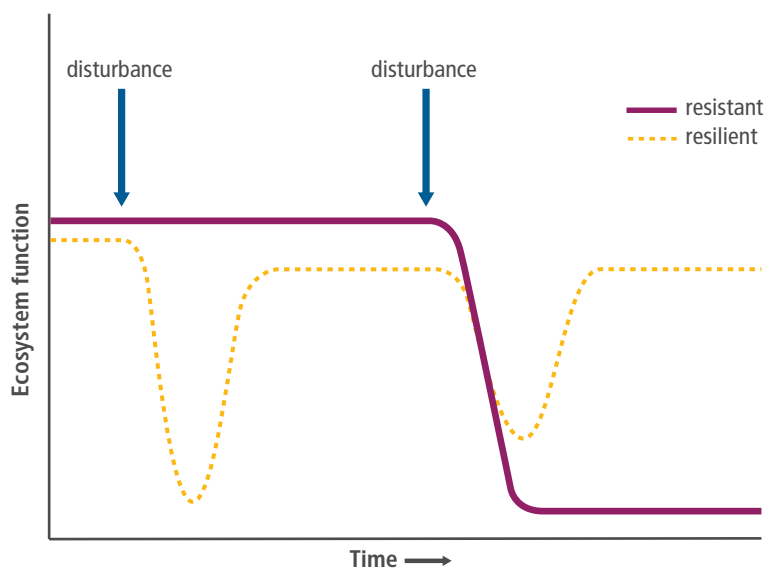
## Ecosystem Resistance

Resistance is the ability of an ecosystem to resist change from a disturbance. Some ecosystems are highly resistant to change while others have little resistance. Highly resistant ecosystems remain essentially unchanged when a disturbance occurs.

Even the most resistant ecosystem can be stressed beyond its ability to recover. In the past, the forests along the ridges of the Appalachian Mountains have recovered from repeated wind, snow, and wildfire damage but are now slowly dying from the effects of acid rain.

### Resistance and Resilience in Ecosystems

**FIGURE 16:** Resistant ecosystems remain unchanged after a disturbance occurs, while a resilient ecosystem quickly rebounds. This graph shows a simplified version of how ecosystem function might respond to disturbances in resistant versus resilient ecosystems.




Resistant ecosystems initially show little impact caused by disturbances. However, if disturbances become too intense, ecosystem structure and function may be severely impacted. As shown in Figure 16, after a second disturbance, the example resistant ecosystem is not able to recover as easily. A resilient ecosystem is often immediately impacted by even low-intensity disturbances but can quickly recover structurally and functionally to levels approaching the conditions before the disturbance occurred.

**Explain** The concepts of resistance and resilience shown in the graph can be applied to other situations too. Thanks to scientific advances and technology, we now have many medicines to treat diseases caused by pathogens. Does this make humans more or less resilient as a species? Does it make humans more or less resistant? Explain your reasoning.

**Gather Evidence** Think back to the volcanic eruption on the island. Once the lava cooled, plants began to grow. Is this an example of a stable ecosystem? Use evidence from the discussion of resilient and resistant ecosystems to support your answer.

# Ecological Succession

The area surrounding the Kilauea volcano on the island of Hawaii is a prime example of what happens when an ecosystem undergoes a devastating disturbance. What was once a lush tropical ecosystem is now covered in bare volcanic rock. Over time, this new volcanic rock will undergo a series of changes. Ecological succession is the sequence of biotic changes that restore a damaged community or create a community in a previously uninhabited area. Two types of ecological succession occur: primary and secondary.

## Primary Succession

**Analyze** Where do pioneer species come from?

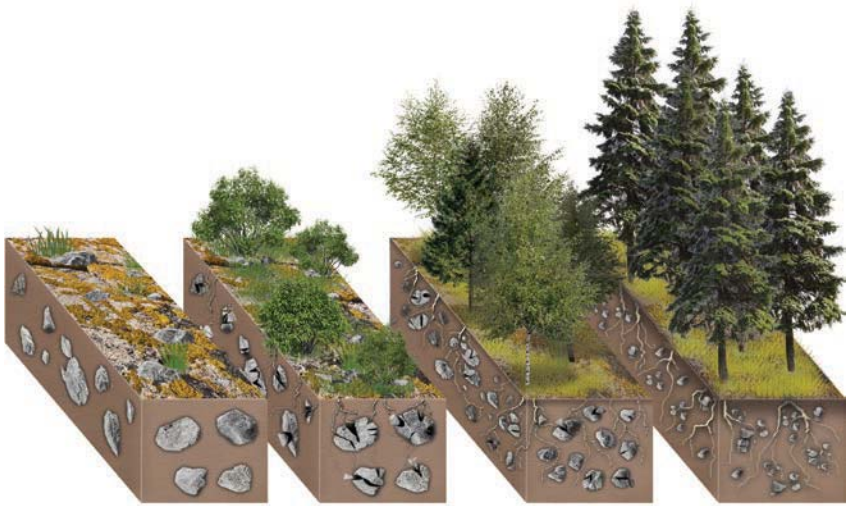
Primary succession, shown in Figure 17, is the establishment and development of an ecosystem in an area that was previously uninhabited, usually a bare rock surface. Melting glaciers, volcanic eruptions, and landslides all begin the process of primary succession. The first organisms that move into this area are called *pioneer species*. These organisms, such as mosses and lichens, break down solid rock into smaller pieces. Once pioneer species have made soil, plants such as grasses can begin to grow. Over time, shrubs and trees replace the grasses to form a forest. This process continues until a climax community is established.

Explore Online

**Hands-On Lab**

**Using GPS in Ecological Surveys** Perform a survey by collecting and recording samples of plant life from a given area of land. Find and map their exact location using GPS, and analyze the data.

**FIGURE 17:** It can take hundreds of years to establish a climax community. This diagram shows the process of primary succession in a boreal forest.



**a** **0–15 years** Moss, lichens, grasses

**b** **15–80 years** Shrubs, cottonwoods, alder thicket

**c** **80–115 years** Transition to forest, alder, spruce

**d** **115–200 years** Hemlock-spruce forest

**Explain** Do you think tall trees are the final stage of primary succession in every biome? Explain your answer.

## Secondary Succession

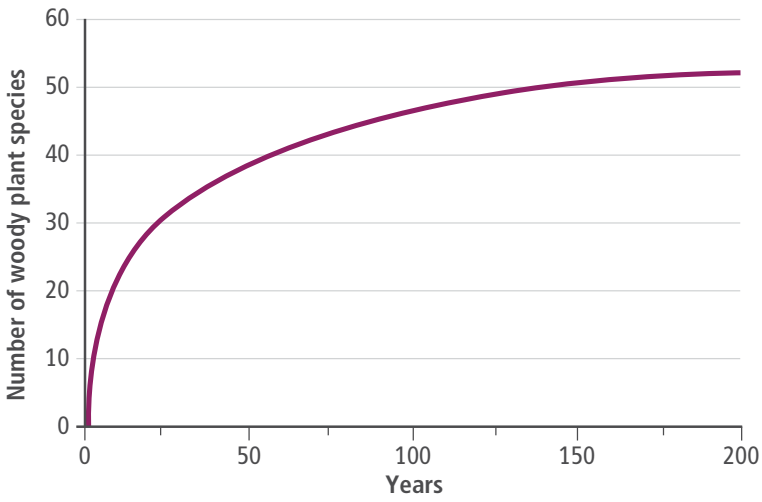
Secondary succession is the reestablishment of an ecosystem in an area where the soil was left intact, such as after a fire or flood. Because soil is already present in the ecosystem, secondary succession reaches the climax community stage more rapidly than primary succession. The process of regrowth is begun by the plants, seeds, and other organisms that remain after the disturbance occurs.

As with primary succession, biodiversity of the ecosystem typically increases as secondary succession progresses. One reason for increased biodiversity is the return of animals as the plant population grows. In addition, animals bring in seeds from plants in other ecosystems on their fur and in their waste, which will establish new plant populations if conditions are favorable for growth.

**Model** Make a model that shows the difference between primary and secondary succession. Make sure your model explains how long each step takes and why.

### Data Analysis

**FIGURE 18:** The amount of species richness in an ecosystem is related to its stage of succession.




**Analyze** Think about how an ecosystem changes during secondary succession. Refer to the graph in Figure 18 to answer the following questions.

1. When does species richness increase at the fastest rate? Why is this possible?
2. Why does the species richness not continue to rise over time? Explain.

Succession is an ongoing process. Even after the climax community is reestablished, changes continue to occur. Small disturbances, such as a tree falling, restart the process. For this reason, an ecosystem is generally never really permanently established—the processes of succession are always causing changes in an ecosystem.

**Gather Evidence** How does ecological succession affect biodiversity? Use evidence gathered from this lesson to support your claims.

# Language Arts Connection

**FIGURE 19:** A specially designed air tanker drops a load of fire retardant to slow the progress of a California wildfire.

## Should Forest Fires Be Suppressed?

Forest fires can cause considerable damage to forest ecosystems; therefore, wildland firefighters work hard to contain and put out forest fires. They use heavy equipment, such as bulldozers, to stop the spread of wildfires. Sometimes airplanes and helicopters carrying water or fire retardant are also used to put out the fires, as shown in Figure 19.

Fire is a natural part of many ecosystems. It cycles nutrients back into the soil from plants. In some forests, shrubs growing underneath the trees are naturally removed by cyclically occurring fires. In most cases, these fires leave the trees and other organisms living in the ecosystem unharmed. With increased efforts to prevent and stop forest fires, shrubs and other understory species grow thick. When a fire does occur, it burns extremely hot and catches the trees on fire. This can have a catastrophic impact on the forest as a whole.

After major forest fires in the late 1800s, early conservationists became concerned about the effect of wildfire on future timber supplies. In 1905, they convinced the United States government to establish the U.S. Forest Service. This agency developed fire protection practices in an effort to conserve what came to be known as national forests.

Just five years later, a series of fires burned 3 million acres over a three-state region. The "Big Blowup," as it was called, changed national thinking about fire management. State and Federal forest officials decided the best way to protect the national forests was to completely suppress any and all wildfires. To that end, policies were enacted that were designed to stop fires completely when possible and put out any fire that did occur as rapidly as possible.

At the time, conservationists and foresters did not understand fire's ecological importance to a forest ecosystem. They believed all fire was bad, because it damaged timber, an economically important resource. As a result, they banned the use of fire to clear underbrush and improve soil. They also constructed roads, watchtowers, and ranger stations to make it easier to detect and reach any forest fire quickly.

In the 1930s, a firefighter corps was established that could be sent anywhere a forest fire occurred. As technology advanced, airplanes and helicopters were added to the ground equipment to drop firefighters and fire-suppression chemicals wherever they were needed. Today, the National Interagency Fire Center (NIFC) coordinates and supports the deployment, training, and certification of firefighters, equipment, and support staff nationwide.

Through continued research, scientists found that fire can actually be helpful to some ecosystems, and Forest Service officials began to realize that fire suppression led to a buildup of fuel that made fires much more hazardous when they did break out. This led to a change in policy that allowed for prescribed burns to manage fuel loads in certain forests and other wildlands, based on the ecological needs of the area.

How do officials decide where and when a wildfire should be fought instead of being allowed to burn? Ecosystem characteristics play a major role in these decisions. For example, stands of Rocky Mountain lodgepole pines need regular exposure to fires severe and intense enough to wipe out the stand and allow a new one to grow in its place. Other plants depend on fire as part of their reproductive strategies. For example, the cones from sequoia trees need fire to open and release their seeds. Fire also exposes bare soil where the seeds can take root and opens the forest canopy, allowing light to reach the seedlings, which helps them grow. On the other hand, wildfires in zones near human populations require active suppression to protect life and property. As human development takes over what were once wild spaces, the potential for widespread catastrophe increases.

Climate affects fire management policy as well. Naturally occurring events such as the yearly Santa Ana winds that blow along coastal Southern California and northern Baja California contribute to the outbreak and spread of wildfires. Lightning strikes, heat waves, and droughts also increase the occurrence of wildfires. Climate change is beginning to increase the severity of weather phenomena that contribute to wildfires. These fire events increase the amount of stored carbon released into the atmosphere. All of these factors require officials to be flexible in their policy decisions.

Lastly, cost figures into the development of fire management policies. Fighting wildfires is expensive in terms of hours worked, transportation, and equipment costs. Wildfires also cause economic damage to communities and endanger lives. Officials must weigh these factors when determining whether to practice fire-suppression policies.

**FIGURE 20:** Forest fires can cause significant economic damage to cities and towns in their path.

### Language Arts Connection

Some policymakers think that natural wildfires should be allowed to burn or that controlled burns should be used as a forestry management tool. Others argue that the risk of letting fires burn or starting controlled burns pose a hazard to the forests and people. Select a position on whether or not to allow controlled burns. Research to learn about the pros and cons of controlled burns.

Gather information and write a one-page position paper. Your paper should discuss your viewpoint and cite evidence from your research to support your claims.

After completing your research and writing your position paper, you will take part in a classroom debate. In the debate, you will have an opportunity to state and defend your position using the information you gathered in your research. Be sure to listen to the students who agree with your position and those who disagree as you make your own arguments.

CASE STUDY: SECONDARY SUCCESSION AT MT. ST. HELENS | SUCCESSION IN DIFFERENT ECOSYSTEMS | THE KEY(STONE) TO ECOSYSTEM STABILITY | Go online to choose one of these other paths.

# Lesson Self-Check

## CAN YOU EXPLAIN IT?

**FIGURE 21:** A lone seedling begins the process of colonizing a field of lava.

Volcanic eruptions play an important role in the formation of new ecosystems, but the resulting lava flows leave behind a hard rock surface that cannot support life. Nevertheless, living things will gradually begin to grow and thrive on this rock surface as it undergoes chemical and physical weathering. Over time, the bare rock will no longer be visible as it becomes covered in soil and plant life.

The Hawaiian Islands began to form more than 70 million years ago following volcanic eruptions in the middle of the Pacific Ocean. As time passed, the process of succession created unique tropical ecosystems. Succession from bare rock to highly diverse vegetation takes a great deal of time. When new eruptions occur, the process of succession begins again, and eventually a stable ecosystem returns.

**Explain** Refer to the notes in your Evidence Notebook and use what you learned in the lesson about succession to explain how a plant is able to grow in the middle of a lava field.

## CHECKPOINTS

### Check Your Understanding

1. Which of the following is a characteristic associated with an organism's niche but not with its habitat?
   - **a.** climate
   - **b.** soil quality
   - **c.** place in the food web
   - **d.** location within the ecosystem

2. Which of the following are factors in determining the stability of an ecosystem? Choose all that apply.
   - **a.** the process by which it recovers after a disturbance
   - **b.** the ability to function during a disturbance
   - **c.** whether a disturbance is natural or human-made
   - **d.** the rate of recovery after a disturbance
   - **e.** the level of biodiversity in the ecosystem

3. An epiphyte is a plant that grows on the surface of another plant, such as a tree. It gets water and nutrients from the air and its surroundings instead of from the tree. The tree is unaffected by the epiphyte's presence. What type of relationship does the epiphyte have with the tree? Explain your reasoning.

4. Whenever *Paramecium aurelia* and *Paramecium caudatum* are placed into the same culture and given a constant supply of food under constant conditions, *P. aurelia* will always outcompete *P. caudatum*, which eventually dies off. What factors prevents *P. caudatum* from surviving in this situation?

5. Ecological succession after a disturbance usually takes hundreds of years in the Pacific Northwest. However, succession after the Mount St. Helens eruption in 1980 has progressed much more rapidly, because some plants and animals were in protected areas when the hot ash and pumice fell. What conclusion can you draw about the pace of succession from this example?

6. Use the following terms to complete the statement:
   *resilient, resistant*
   If an ecosystem is _____, it is generally stable unless drastically changed by a disturbance. When a disturbance causes a change, the ecosystem quickly recovers when it is _____.

7. Ecosystem A and Ecosystem B have the same eight species, but Ecosystem A has a more even distribution of species than Ecosystem B. Which ecosystem is more diverse? Explain your reasoning.

8. Top predators are often keystone species in their habitat. Explain what happens to the biodiversity of an ecosystem when a top predator is deliberately removed from the ecosystem in which it lives.

## MAKE YOUR OWN STUDY GUIDE

In your Evidence Notebook, design a study guide that supports the main idea from this lesson:

**Within an ecosystem, organisms interact with each other and with their environment. The stability of the ecosystem is determined by its biodiversity, resilience, and resistance to change.**

Remember to include the following information in your study guide:

- Use examples that model main ideas.
- Record explanations for the phenomena you investigated.
- Use evidence to support your explanations. Your support can include drawings, data, graphs, laboratory conclusions, and other evidence recorded throughout the lesson.

Consider how ecosystem interactions can be used to analyze ecosystem dynamics and predict how conservation efforts will affect the stability of these ecosystems.