# 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.

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**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

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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?

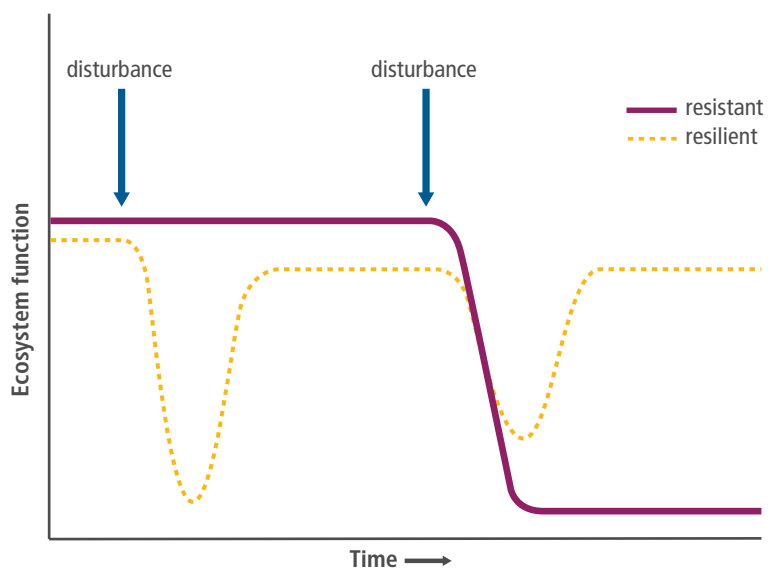
## Ecosystem Resistance

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.