

## THE LONG-TERM STABILITY OF ECOSYSTEMS

Plant communities assemble themselves flexibly, and their particular structure depends on the specific history of the area. Ecologists use the term "succession" to refer to the changes that happen in plant communities and ecosystems over time. The first community in a succession is called a pioneer community, while the long-lived community at the end of succession is called a climax community. Pioneer and successional plant communities are said to change over periods from 1 to 500 years. These changes—in plant numbers and the mix of species—are cumulative. Climax communities themselves change but over periods of time greater than about 500 years.

An ecologist who studies a pond today may well find it relatively unchanged in a year's time. Individual fish may be replaced, but the number of fish will tend to be the same from one year to the next. We can say that the properties of an ecosystem are more stable than the individual organisms that compose the ecosystem.

At one time, ecologists believed that species diversity made ecosystems stable. They believed that the greater the diversity the more stable the ecosystem. Support for this idea came from the observation that long-lasting climax communities usually have more complex food webs and more species diversity than pioneer communities. Ecologists concluded that the apparent stability of climax ecosystems depended on their complexity. To take an extreme example, farmlands dominated by a single crop are so unstable that one year of bad weather or the invasion of a single pest can destroy the entire crop. In contrast, a complex climax community, such as a temperate forest, will tolerate considerable damage from weather or pests.

The question of ecosystem stability is complicated, however. The first problem is that ecologists do not all agree what "stability" means. Stability can be defined as simply lack of change. In that case, the climax community would be considered the most stable, since, by definition, it changes the least over time. Alternatively, stability can be defined as the speed with which an ecosystem returns to a particular form following a major disturbance, such as a fire. This kind of stability is also called *resilience*. In that case, climax communities would be the most fragile and the *least* stable, since they can require hundreds of years to return to the climax state.

Even the kind of stability defined as simple lack of change is not always associated with maximum diversity. At least in temperate zones, maximum diversity is often found in mid-successional stages, not in the climax community. Once a redwood forest matures, for example, the kinds of species and the number of individuals growing on the forest floor are reduced. In general, diversity, by itself, does not ensure stability. Mathematical models of ecosystems likewise suggest that diversity does not guarantee ecosystem stability—just the opposite, in fact. A more complicated system is, in general, more likely than a simple system to break down. (A fifteen-speed racing bicycle is more likely to break down than a child's tricycle.)

Ecologists are especially interested in knowing what factors contribute to the resilience of communities because climax communities all over the world are being severely damaged or destroyed by human activities. The destruction caused by the volcanic explosion of Mount St. Helens, in the northwestern United States, for example, pales in comparison to the destruction caused by humans. We need to know what

GO ON TO THE NEXT PAGE ➤



aspects of a community are most important to the community's resistance to destruction, as well as its recovery.

Many ecologists now think that the relative long-term stability of climax communities comes not from diversity but from the "patchiness" of the environment; an environment that varies from place to place supports more kinds of organisms than an environment that is uniform. A local population that goes extinct is quickly replaced by immigrants from an adjacent community. Even if the new population is of a different species, it can approximately fill the niche vacated by the extinct population and keep the food web intact.

PARAGRAPH  
1

Plant communities assemble themselves flexibly, and their particular structure depends on the specific history of the area. Ecologists use the term "succession" to refer to the changes that happen in plant communities and ecosystems over time. The first community in a succession is called a pioneer community, while the long-lived community at the end of succession is called a climax community. Pioneer and successional plant communities are said to change over periods from 1 to 500 years. These changes—in plant numbers and the mix of species—are cumulative. Climax communities themselves change but over periods of time greater than about 500 years.

**Directions:** Mark your answer by filling in the oval next to your choice.

1. The word "particular" in the passage is closest in meaning to
  - ☐ natural
  - ☐ final
  - ☐ specific
  - ☐ complex
2. According to paragraph 1, which of the following is NOT true of climax communities?
  - ☐ They occur at the end of a succession.
  - ☐ They last longer than any other type of community.
  - ☐ The numbers of plants in them and the mix of species do not change.
  - ☐ They remain stable for at least 500 years at a time.

PARAGRAPH  
2

An ecologist who studies a pond today may well find it relatively unchanged in a year's time. Individual fish may be replaced, but the number of fish will tend to be the same from one year to the next. We can say that the properties of an ecosystem are more stable than the individual organisms that compose the ecosystem.

3. According to paragraph 2, which of the following principles of ecosystems can be learned by studying a pond?
  - ☐ Ecosystem properties change more slowly than individuals in the system.
  - ☐ The stability of an ecosystem tends to change as individuals are replaced.
  - ☐ Individual organisms are stable from one year to the next.
  - ☐ A change in the numbers of an organism does not affect an ecosystem's properties.



## PARAGRAPH 3

At one time, ecologists believed that species diversity made ecosystems stable. They believed that the greater the diversity the more stable the ecosystem. Support for this idea came from the observation that long-lasting climax communities usually have more complex food webs and more species diversity than pioneer communities. Ecologists concluded that the apparent stability of climax ecosystems depended on their complexity. To take an extreme example, farmlands dominated by a single crop are so unstable that one year of bad weather or the invasion of a single pest can destroy the entire crop. In contrast, a complex climax community, such as a temperate forest, will tolerate considerable damage from weather or pests.

4. According to paragraph 3, ecologists once believed that which of the following illustrated the most stable ecosystems?
- ☐ Pioneer communities
  - ☐ Climax communities
  - ☐ Single-crop farmlands
  - ☐ Successional plant communities

## PARAGRAPH 4

The question of ecosystem stability is complicated, however. The first problem is that ecologists do not all agree what "stability" means. Stability can be defined as simply lack of change. In that case, the climax community would be considered the most stable, since, by definition, it changes the least over time. Alternatively, stability can be defined as the speed with which an ecosystem returns to a particular form following a major disturbance, such as a fire. This kind of stability is also called *resilience*. In that case, climax communities would be the most fragile and the *least* stable, since they can require hundreds of years to return to the climax state.

5. According to paragraph 4, why is the question of ecosystem stability complicated?
- ☐ The reasons for ecosystem change are not always clear.
  - ☐ Ecologists often confuse the word "stability" with the word "resilience."
  - ☐ The exact meaning of the word "stability" is debated by ecologists.
  - ☐ There are many different answers to ecological questions.
6. According to paragraph 4, which of the following is true of climax communities?
- ☐ They are more resilient than pioneer communities.
  - ☐ They can be considered both the most and the least stable communities.
  - ☐ They are stable because they recover quickly after major disturbances.
  - ☐ They are the most resilient communities because they change the least over time.

GO ON TO THE NEXT PAGE ➡



PARAGRAPH  
5

Even the kind of stability defined as simple lack of change is not always associated with maximum diversity. At least in temperate zones, maximum diversity is often found in mid-successional stages, not in the climax community. Once a redwood forest matures, for example, the kinds of species and the number of individuals growing on the forest floor are reduced. In general, diversity, by itself, does not ensure stability. Mathematical models of ecosystems likewise suggest that diversity does not guarantee ecosystem stability—just the opposite, in fact. A more complicated system is, in general, more likely than a simple system to break down. (A fifteen-speed racing bicycle is more likely to break down than a child's tricycle.)

7. Which of the following can be inferred from paragraph 5 about redwood forests?
- ☐ They become less stable as they mature.
  - ☐ They support many species when they reach climax.
  - ☐ They are found in temperate zones.
  - ☐ They have reduced diversity during mid-successional stages.
8. The word "guarantee" in the passage is closest in meaning to
- ☐ increase
  - ☐ ensure
  - ☐ favor
  - ☐ complicate
9. In paragraph 5, why does the author provide the information that "A fifteen-speed racing bicycle is more likely to break down than a child's tricycle"?
- ☐ To illustrate a general principle about the stability of systems by using an everyday example
  - ☐ To demonstrate that an understanding of stability in ecosystems can be applied to help understand stability in other situations
  - ☐ To make a comparison that supports the claim that, in general, stability increases with diversity
  - ☐ To provide an example that contradicts mathematical models of ecosystems



PARAGRAPH  
6

Ecologists are especially interested in knowing what factors contribute to the resilience of communities because climax communities all over the world are being severely damaged or destroyed by human activities. The destruction caused by the volcanic explosion of Mount St. Helens, in the northwestern United States, for example, pales in comparison to the destruction caused by humans. We need to know what aspects of a community are most important to the community's resistance to destruction, as well as its recovery.

10. The word "pales" in the passage is closest in meaning to
- ☐ increases proportionally
  - ☐ differs
  - ☐ loses significance
  - ☐ is common

PARAGRAPH  
7

Many ecologists now think that the relative long-term stability of climax communities comes not from diversity but from the "patchiness" of the environment; an environment that varies from place to place supports more kinds of organisms than an environment that is uniform. A local population that goes extinct is quickly replaced by immigrants from an adjacent community. Even if the new population is of a different species, it can approximately fill the niche vacated by the extinct population and keep the food web intact.

11. Which of the sentences below best expresses the essential information in the highlighted sentence in the passage? Incorrect choices change the meaning in important ways or leave out essential information.
- ☐ Ecologists now think that the stability of an environment is a result of diversity rather than patchiness.
  - ☐ Patchy environments that vary from place to place do not often have high species diversity.
  - ☐ Uniform environments cannot be climax communities because they do not support as many types of organisms as patchy environments.
  - ☐ A patchy environment is thought to increase stability because it is able to support a wide variety of organisms.
12. The word "adjacent" in the passage is closest in meaning to
- ☐ foreign
  - ☐ stable
  - ☐ fluid
  - ☐ neighboring

GO ON TO THE NEXT PAGE ➡



■ Ecologists are especially interested in knowing what factors contribute to the resilience of communities because climax communities all over the world are being severely damaged or destroyed by human activities. ■ The destruction caused by the volcanic explosion of Mount St. Helens, in the northwestern United States, for example, pales in comparison to the destruction caused by humans. ■ We need to know what aspects of a community are most important to the community's resistance to destruction, as well as its recovery. ■

13. Look at the four squares [■] that indicate where the following sentence could be added to the passage.

**In fact, damage to the environment by humans is often much more severe than by natural events and processes.**

Where would the sentence best fit?

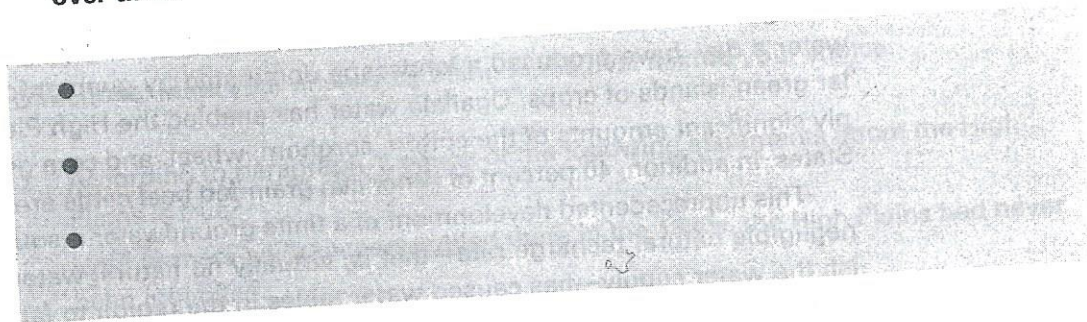
- ☐ **In fact, damage to the environment by humans is often much more severe than by natural events and processes.** Ecologists are especially interested in knowing what factors contribute to the resilience of communities because climax communities all over the world are being severely damaged or destroyed by human activities. ■ The destruction caused by the volcanic explosion of Mount St. Helens, in the northwestern United States, for example, pales in comparison to the destruction caused by humans. ■ We need to know what aspects of a community are most important to the community's resistance to destruction, as well as its recovery. ■
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14. **Directions:** An introductory sentence for a brief summary of the passage is provided below. Complete the summary by selecting the THREE answer choices that express the most important ideas in the passage. Some answer choices do not belong in the summary because they express ideas that are not presented in the passage or are minor ideas in the passage. **This question is worth 2 points.**

**The process of succession and the stability of a climax community can change over time.**



#### Answer Choices

1. The changes that occur in an ecosystem from the pioneer to the climax community can be seen in one human generation.
2. Ecologists agree that climax communities are the most stable types of ecosystems.
3. A high degree of species diversity does not always result in a stable ecosystem.
4. Disagreements over the meaning of the term "stability" make it difficult to identify the most stable ecosystems.
5. The level of resilience in a plant community contributes to its long-term stability.
6. The resilience of climax communities makes them resistant to destruction caused by humans.

GO ON TO THE NEXT PAGE ➡