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AP<sup>®</sup>

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# AP<sup>®</sup> Biology

## Sample Student Responses and Scoring Commentary

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**Question 5: Analyze a Model or Visual Representation****4 points**

Annual plants complete their life cycle, including germination, seed production, and death, within one year. *Ambrosia trifida* (giant ragweed) is an annual plant that readily colonizes any land that has had a disturbance such as plowing. The plant is considered an invasive species in regions outside of its native range. In a particular region, the seeds of *A. trifida* germinate from early March through the end of the summer, while the seeds of other annual plants require warmer soil temperatures and thus germinate from late April through the end of the summer.

Researchers studied the influence of *A. trifida* on the biodiversity of other annual plant species that grow in the same field. In early spring, the researchers marked off identical plots of land in a field that had been plowed the previous fall and not replanted with new crops. All plants that grew on one half of the plots were left untouched (Figure 1A), while all germinating *A. trifida* seedlings were removed from the other half of the plots throughout the spring and summer (Figure 1B). In late summer, the researchers counted and identified all plants that grew in the plots. The distribution of plants is represented by the symbols in Figures 1A and 1B.

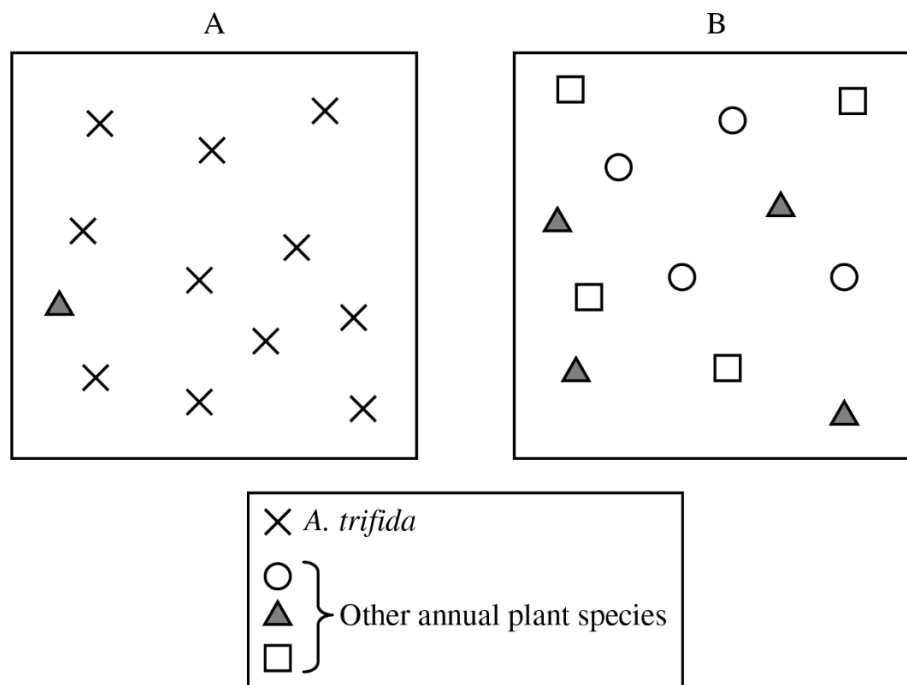


Figure 1. Representations of plant identity and distribution in experimental plots in late summer. Each box represents one typical experimental plot, and each symbol represents 10 individual plants.

(a) **Describe** a cause of logistic growth of the ragweed population. **1 point**

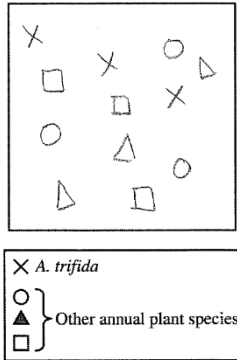
Accept one of the following:

- A factor that becomes limiting would cause the population size to stabilize.
- Space/sunlight/herbivory/phosphorus/nitrogen/other density-dependent factor becomes limiting, and the population stabilizes.

(b) Based on the representation in Figure 1, **explain** why the scientists claim that plot B would be more resilient than plot A in response to a sudden environmental change. **1 point**

- (Plot B is more resilient) because it has much greater (species) diversity than plot A does.

- (c) In a third group of plots, the researchers removed all seedlings of all plants that germinated before June 1. All plants that germinated after June 1 were left untouched. Using the template in the space provided for your response and the symbols shown in Figure 1, **represent** the expected plant species that would be found in this third group of plots three months later. Draw no more than 12 symbols. Assume all other environmental conditions are the same as for the initial study described. **1 point**

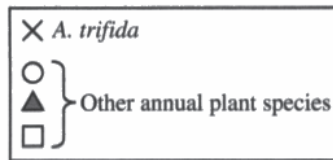
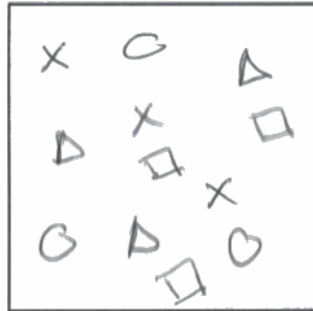


- All four species, including *A. trifida*, must be added to the template.

- (d) **Explain** how an invasive species such as ragweed affects ecosystem biodiversity, as illustrated in Figure 1. **1 point**
- The explanation requires a process or relationship - and must state that biodiversity decreases.
  - Examples of appropriate responses include:
    - There are no predators of the invasive species, so its population grows faster and reduces biodiversity.
    - The invasive species germinates earlier, uses up resources, and reduces biodiversity.
    - The invasive species outcompetes other species and reduces biodiversity.

**Total for question 5 4 points**

Begin your response to **QUESTION 5** on this page. Do not skip lines.

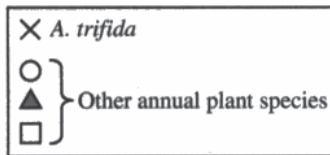
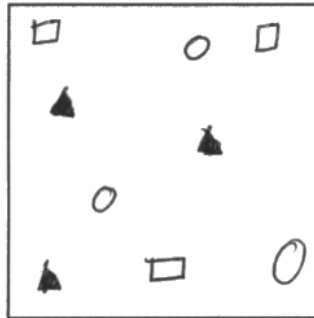


- Ⓐ One cause of logistic growth is that the space the ragweeds have to grow in <sup>on the field is</sup> ~~is~~ limited so that limits the size the population can reach. It is a density dependent factor that causes the population to level off at carrying capacity instead of continuing to grow exponentially. (leading to logistic growth)
- Ⓑ Plot B would be more resilient because it has a greater amount of biodiversity and through that genetic diversity. This means that if a sudden change occurred in the climate there is more of a chance something will survive from B (because there are more <sup>of plants</sup> different types with different genes) than A.

Continue your response to **QUESTION 5** on this page. Do not skip lines.

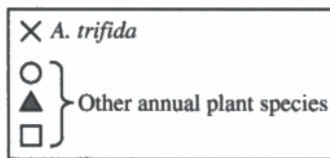
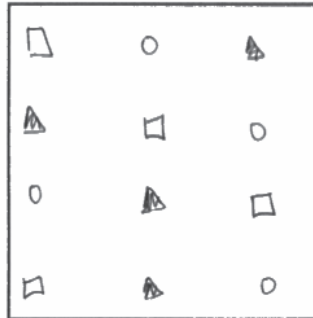
④ Invasive species reduce biodiversity by out competing many different types of native species for resources. This causes the invasive species to take over and the different types of native species to decline leaving a lot more of one type of organism in the ecosystem than before.

Begin your response to **QUESTION 5** on this page. Do not skip lines.



Logistic growth of the rag weed population is caused by the plants ability to start its life cycle from early March, to spread further and to occupy more land. Plot B would be more resilient since the plant diversity is greater than that of Plot A. Invasive species ruin an ecosystem's biodiversity. This is because of the species to dominate its competition for resources. As such the invasive species can grow and force its native counterparts out of an ecosystem. The biodiversity then becomes lower as a result.

Begin your response to **QUESTION 5** on this page. Do not skip lines.



- a.) A cause of logistic growth of the ragweed population could be resistance to pesticides or insects.
- b.) Scientists claim that plot B would be more resilient than plot A in response to a sudden environmental change because there is greater diversity.
- d.) An invasive species takes over and eliminates biodiversity from the ecosystem.

## Question 5

**Note:** Student samples are quoted verbatim and may contain spelling and grammatical errors.

### Overview

This question described a field experiment in which all germinating seedlings of the invasive weed *Ambrosia trifida* (giant ragweed) were removed from some experimental plots, while other plots were left untouched. Figure 1 showed the plant identity and distribution in typical plots (plot A and plot B) by representing *A. trifida* and other annual plant species with different symbols.

In part (a) students were asked to describe a cause of logistic growth of the ragweed population. Responses were expected to demonstrate an understanding that resource availability limits population growth (SYI-1.H.2 in Topic 8.4).

In part (b) students were asked to explain why plot B would be more resilient than plot A if exposed to a sudden environmental change. Responses were expected to demonstrate an understanding that more diverse ecosystems are more resilient to environmental changes (SYI-3.F.1 in Topic 8.6) and proficiency in analyzing a visual representation (Science Practice 2).

Part (c) described a third group of plots in which researchers removed all seedlings that emerged prior to June 1, then left untouched the plants that emerged after June 1. Students were asked to represent the plant species that would be expected to emerge in these plots, using the same symbols used in Figure 1. Responses were expected to demonstrate an understanding of how interactions among populations can influence community structure (ENE-4.B.4 in Topic 8.5) and proficiency in representing relationships with a diagram (Science Practice 2.D).

In part (d) students were asked to explain how an invasive species such as ragweed affects ecosystem biodiversity. Responses were expected to demonstrate an understanding of how invasive species affect ecosystem dynamics (SYI-2.A in Topic 8.7).

### Sample: 5A

#### Score: 4

The response earned 1 point in part (a) for describing that space becomes limiting, and that causes the population to stabilize. The response earned 1 point in part (b) because it explains that plot B is more resilient because it has greater “biodiversity” than plot A. The response earned 1 point in part (c) because all four species (shapes) are depicted on the template. The response earned 1 point in part (d) for explaining that “invasive species reduce biodiversity by out competing ... native species.”

### Sample: 5B

#### Score: 2

The response did not earn a point in part (a) because it does not describe a limiting factor that would cause the population size to stabilize. The response earned 1 point in part (b) because it explains that plot B is more resilient because the “plant diversity is greater than that of plot A.” The response did not earn a point in part (c) because *A. trifida* is not represented on the template. The response earned 1 point in part (d) because it explains that the invasive species can “dominate its competition for resources” AND that “biodiversity then becomes lower as a result.”



### Question 5 (continued)

**Sample: 5C**

**Score: 1**

The response did not earn a point in part (a) because it does not describe a factor that causes the population size to stabilize. The response earned 1 point in part (b) because it explains that plot B is more resilient because it has greater diversity than plot A has. The response did not earn a point in part (c) because *A. trifida* is not depicted on the template. The response did not earn a point in part (d) because it does not explain how invasive species lower biodiversity.