

**AP<sup>®</sup> BIOLOGY**  
**2006 SCORING GUIDELINES**

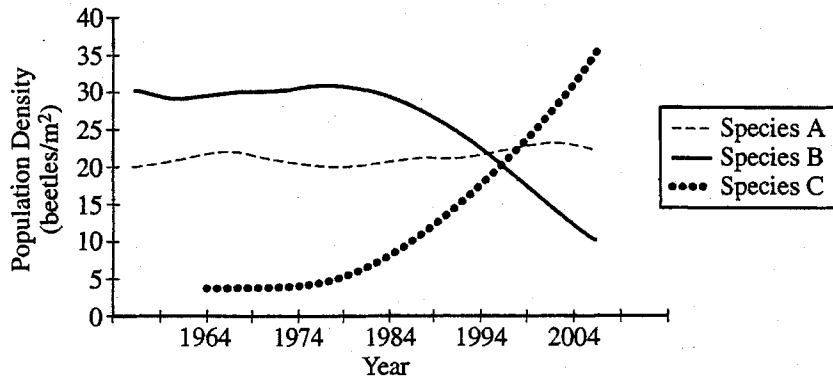
**Question 2**

According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.

- (a) **Propose** an explanation for the pattern of population density observed in species C. **[3 points]**
1. Description of curve [1 point]: Type of growth is exponential growth (logarithmic or J-shaped curve acceptable).
  2. Explanation must describe the growth using an understanding of [1 point each, 2 points maximum]:
    - Lack of limiting factors
    - Low competition
    - Abundant food
    - Low predation
    - Ideal environmental conditions (habitat, temperature, moisture, etc.)
    - Access to mates
- (b) **Describe** the effect that the introduction of beetle species C has had on the population density of species A and species B. **Propose** an explanation for the patterns of population density observed in species A and in species B. **[4 points]**
1. Describe effect [1 point]: Species C has had little or **no effect** on species A; however, as **species C increases, B decreases. Both lines must be addressed for the point.**
  2. Explanation for species A or dashed line [1 point]: **No or little competition** (No niche overlap).
  3. Explanation for species B or solid line [1 point]: **Competition or Niche overlap.**
  4. Identification of the niche **“Competitive Exclusion Principle”** [1 point]: by name or description.
- (c) **Predict** the population density of species C in 2014. Provide a biological **explanation** for your prediction. **[2 points]**
1. Prediction [1 point]: The population will **increase, decrease, or stabilize (level off).**
  2. Explanation [1 point]: Tie a correct explanation to the prediction.
    - Increase**—tie to abundant resources and freedom from competition.
    - Decrease**—tie to exhaustion of a key resource or density-dependent cause.
    - Stabilize or level off**—tie to carrying capacity or a limiting resource.
- (d) **Explain** why invasive species are often successful in colonizing new habitats. **[2 points—from either or both areas below]**
1. They have **lost a controlling population factor** from their original habitat: predator, pathogen, or parasite.
  2. They **have a novel evolutionary advantage** brought to the island from their original habitat: an aspect that provides an advantage—a chemical defense, flight advantage, novel enzyme, etc.

VARIATION IN POPULATION DENSITY OF BEETLES

2A1



2. According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.
- Propose an explanation for the pattern of population density observed in species C.
  - Describe the effect that the introduction of beetle species C has had on the population density of species A and species B. Propose an explanation for the patterns of population density observed in species A and in species B.
  - Predict the population density of species C in 2014. Provide a biological explanation for your prediction.
  - Explain why invasive species are often successful in colonizing new habitats.

a. Species C grows in a J-curve of exponential growth because it is an invasive species that uses adaptive radiation to adapt to its environment and become fit for survival. It outcompetes competitor species for nutrition, habitat, and water.

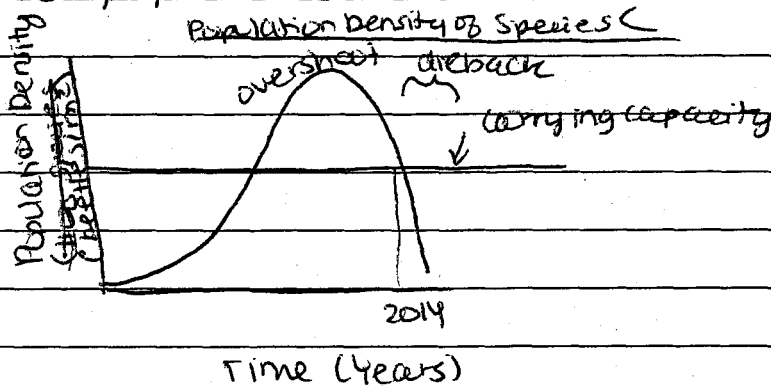
b. Species C has no effect on species A. The two beetles may occupy slightly different niches and thus be able to live side by side. Species A's population remains relatively stable. Species B, however, is reduced by the introduction of species C. Species B and C occupy identical niches and become competitors for the same resources. The

GO ON TO THE NEXT PAGE.

2A2

Competitive exclusion principle states that one species must die out or move while the second species survives, proving it is the most fit for that niche. Species C outcompetes B, causing extinction or emigration of Species B.

c. Species C will continue to grow exponentially, but also follow logistic growth. Depleting resources are limiting factors that make the population level  $K$  at the environment's carrying capacity. However, by 2014, the J-curve may exceed the carrying capacity, resulting in overshoot. Such rapid growth will result in rapid dieback of Species C until very low populations remain.



d. Invasive species successfully colonize in new habitats because they are r-strategists or prolific breeders. In their new habitat, invasives do not have the natural predators or diseases that contain their populations back home. Invasive species grow aggressively, completely outcompeting natives.

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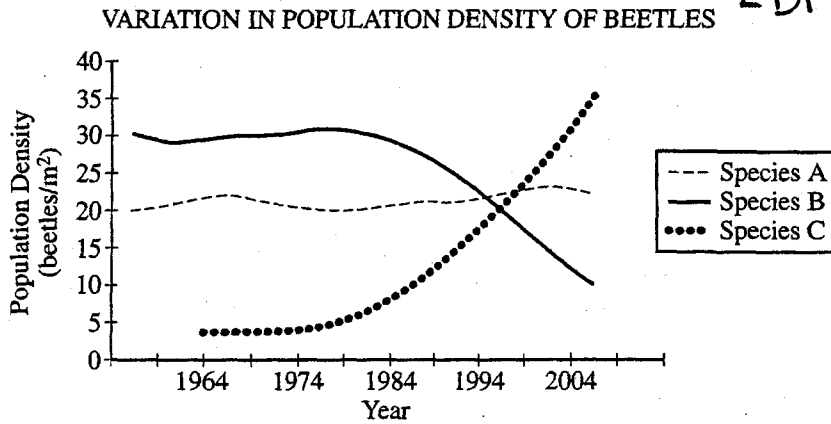
2A<sub>3</sub>

ADDITIONAL PAGE FOR ANSWERING QUESTION 2

for resources. They can also produce harmful  
toxins that stunt the growth of nearby organisms.  
This happens in plants that toxify soils so  
surrounding plants die.

GO ON TO THE NEXT PAGE.

2B1



2. According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.
- (a) **Propose** an explanation for the pattern of population density observed in species C.
  - (b) **Describe** the effect that the introduction of beetle species C has had on the population density of species A and species B. **Propose** an explanation for the patterns of population density observed in species A and in species B.
  - (c) **Predict** the population density of species C in 2014. Provide a biological explanation for your prediction.
  - (d) **Explain** why invasive species are often successful in colonizing new habitats.

a) The pattern of population density in species C is a increasing population with an increasing slope.

b) When species C was introduced to the island, the population of species A stayed the same but the population of species B began to decline.

GO ON TO THE NEXT PAGE.

This is probably because A and C are not similar in species so they probably eat different foods and have no affect on each other.

However, species B is probably very similar to C. When C came, they ate all of the food that B previously ate. This increased competition for nutrients meant that species started to decline because they didn't have the resources to exist simultaneously.

c) In 2014, species will probably be around 45 beetles per m<sup>2</sup>. They will continue to increase until they reach a carrying capacity where there just ~~isn't~~ isn't enough resources on the island for so many beetles.

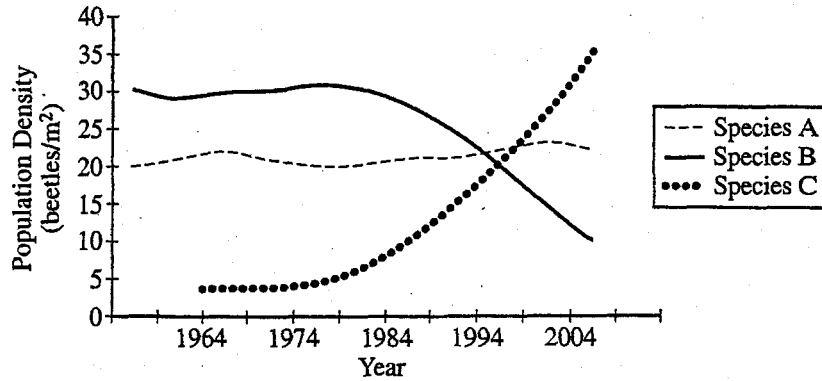
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d) Invasive species are often successful in colonizing new habitats because they are often competitive species who are able to get prey better than non-invasive species.

GO ON TO THE NEXT PAGE.

VARIATION IN POPULATION DENSITY OF BEETLES

201



2. According to fossil records and recent published observations, two species of leaf-eating beetles (species A and B) have existed on an isolated island in the Pacific Ocean for over 100,000 years. In 1964 a third species of leaf-eating beetle (species C) was accidentally introduced on the island. The population size of each species has been regularly monitored as shown in the graph above.

- (a) **Propose** an explanation for the pattern of population density observed in species C.
- (b) **Describe** the effect that the introduction of beetle species C has had on the population density of species A and species B. **Propose** an explanation for the patterns of population density observed in species A and in species B.
- (c) **Predict** the population density of species C in 2014. Provide a biological explanation for your prediction.
- (d) **Explain** why invasive species are often successful in colonizing new habitats.

Species C is able to thrive in the new habitat since it is an invasive species. Species C may be out-competing species A and B for resources, allowing it to successfully reproduce in prime conditions.

Species C is causing a decline in the population density of species B but has no effect on species A, as its population density is fairly constant. Species C may be a parasite of species B, therefore it causes a decline in species B's population while having

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no effect on species A.

The population density of species C will continue to increase. ~~In 2014, there will be about 50 beetles/m<sup>2</sup>.~~ Since in 2014, there will be about 45 beetles/m<sup>2</sup>. I predict this because eventually species C will reach its carrying capacity. Also, if species C is parasitic and thrives off of species B, then ~~all~~ species B will soon no longer exist and species C will have trouble surviving without a host such as species B.

Invasive species can colonize new habitats by competing with existing species for resources or by being parasitic.

GO ON TO THE NEXT PAGE.

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**2006 SCORING COMMENTARY**

**Question 2**

**Overview**

This question dealt with species interactions, the competitive exclusion principle, and the niche concept. Parts (a) and (b) required ecological interpretations of a population density graph. Part (c) asked for a prediction based on the graph and a justification of the prediction. Part (d) asked a more general question about the characteristics of invasive species.

**Sample: 2A**

**Score: 9**

Part (a): By correctly identifying the curve as j-shaped, the response earned 1 point.

Part (b): All 4 possible points were earned. The first point was for an explanation of why species C had no effect on A. The second point was earned in two places—the opening sentence in this part, and the line noting the reduction of species B by C. The third point was earned for explaining why species C impacted B (occupied identical niches and became competitors). The final point was the competitive exclusion principle point.

Part (c): One point was earned for predicting continued exponential growth. A second point was earned for understanding carrying capacity.

Part (d): The response earned 2 points for explaining that invasive species may be successful due to a lack of predators and disease that contain their populations at home.

**Sample: 2B**

**Score: 5**

Part (a): No points were earned.

Part (b): Three points were earned. The first point was for the effect of species C on species A and B. The student then gives an explanation for the steady growth of A and the declining growth of B, earning 2 more points.

Part (c): Two points were earned—1 for the prediction, and 1 for the biological explanation (carrying capacity).

Part (d): No points were earned, as the response is too general.

**Sample: 2C**

**Score: 3**

Part (a): No points were earned.

Part (b): One point was earned for the effect of species C on species A and B. No points were earned for the suggestion that the new beetle is a parasite, since it is given that the beetles eat leaves.

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**2006 SCORING COMMENTARY**

**Question 2 (continued)**

Part (c): Two points were earned—1 for the prediction, and 1 for the biological explanation (carrying capacity).

Part (d): No points were earned.