

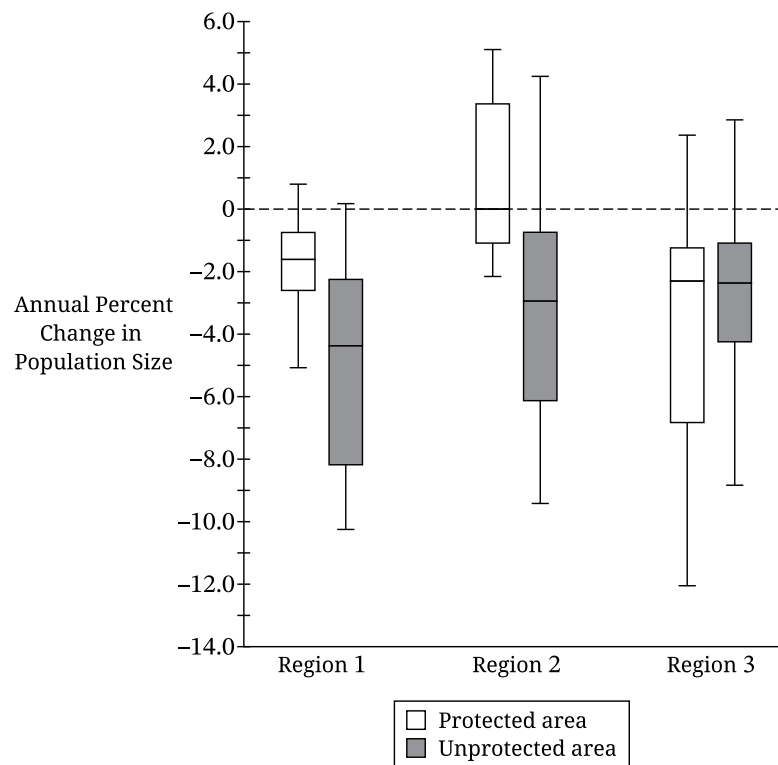
The following information applies to all parts.

6. Many raptors in Africa are top predators and keystone species in their ecosystems. Raptor population sizes have been declining in recent years.

Scientists studied the relationship between the conversion of the raptors' natural habitat into farmland and the population sizes of raptors in those regions. They compiled raptor population size data from three different regions of Africa: Region 1, Region 2, and Region 3. In each of the regions, the scientists compared the annual percent change in the raptor population size in areas that were protected from farming (protected) with the annual percent change in areas where farming occurred (unprotected). Their results are shown in the box and whisker plot.

type of bird

Median Annual Percent Change in the Population Size of Raptors in Protected and Unprotected Areas



Part A

Based on the box and whisker plot, **identify** the median annual percent change in population size in the unprotected area of Region 2.

Part B

Based on the box and whisker plot, **identify** the region and area that experienced the greatest median annual percent change in population size.

Part C

Researchers hypothesize that if farming is eliminated in Region 2, there will no longer be a decline in the raptor population size. Based on the data in the box and whisker plot, **evaluate** the researchers' hypothesis.

Part D

Based on the information provided, **explain** why ecosystem resilience in unprotected areas may decline over time.

STOP
END OF EXAM

4. The common wild oat is native to regions of Europe and Asia but is an invasive species in central California grasslands. In California, the common wild oat has almost completely replaced some species of native bunchgrass. Researchers found that aphids, a type of small insect that often carries plant viruses, have a much higher reproductive rate in grasslands that include the common wild oat than in grasslands composed of only native bunchgrass species. Additionally, the viruses carried by the aphids appear to affect only the native bunchgrasses and not the common wild oat. Native bunchgrasses infected by the virus have much higher death rates than do native bunchgrasses that are not infected.
- (a) **Describe** the change in the resilience of an ecosystem when there is a decrease in the number of species.
- (b) **Explain** how the addition of the common wild oat affects the number of native bunchgrass plants that can be supported by the California grasslands ecosystem.
- (c) Researchers suggest adding ladybugs, predators of aphids, to the California grasslands. **Predict** the effect of adding ladybugs on the abundance of the native bunchgrass population.
- (d) **Justify** your prediction in part (c).

Write your responses to this question only on the designated pages in the separate Free Response booklet.

If there are multiple parts to this question, write the part letter with your response.

3. Sand lances of the genus *Ammodytes* are small fish that function as keystone organisms in several coastal ecosystems. These sand lances are prey fish that support organisms at higher trophic levels. Scientists performed experiments to examine how sand lance populations are likely to be affected by the rising temperatures and CO₂ levels associated with climate change.

Sand lance embryos typically develop and mature into adult fish at low temperatures (approximately 5°C) and stable, low CO₂ levels (approximately 400 µatm). Over the course of two years, the scientists measured the survival rate of sand lance embryos allowed to develop and mature in a laboratory at three different temperatures, 5°C, 7°C, and 10°C, with the level of CO₂ maintained at 400 µatm, 1,000 µatm, and 2,100 µatm for each temperature.

- (a) **Describe** the effect of increased biodiversity on the resilience of an ecosystem in a changing environment.
- (b) **Justify** the scientists' selecting 5°C as the lowest temperature and 400 µatm as the lowest CO₂ level in their study of sand lance embryo survival.
- (c) **State** a null hypothesis for the experiment.
- (d) The scientists claim that a reduction in the population size of the *Ammodytes* sand lances will affect the stability of the entire coastal ecosystem. Provide reasoning to **support** the scientists' claim.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

5. The following models represent all the interacting species in two different communities with some of the same species and feeding relationships. These models assume that both communities have the same initial biomass. The models can be used to understand the effects of human activities on the communities.

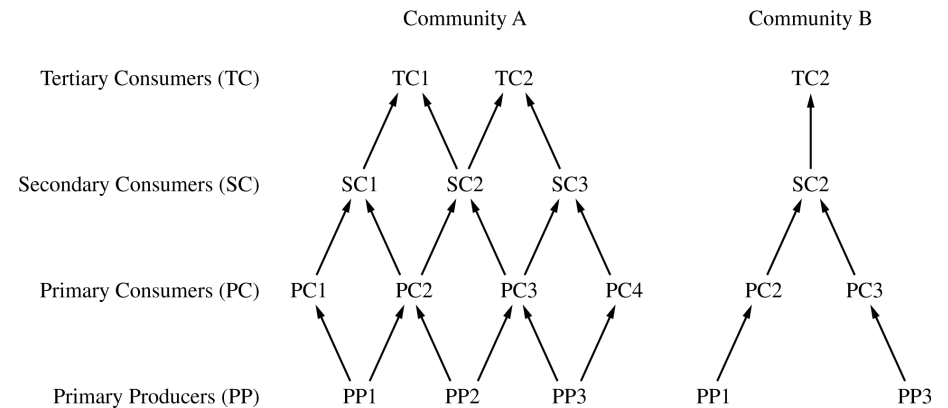


Figure 1. Models of two different communities with some of the same species

- (a) **Describe** a characteristic of a community that makes a species invasive in that community but not invasive in a different community.
- (b) **Explain** why removing species PP1 will have a greater effect on community B than on community A.
- (c) An invasive species (INV) that eats individuals of species SC2 is introduced into community B. Using the template in the space provided for your response, for community B, indicate the feeding relationship for this invasive species by correctly placing **INV** to represent the invasive species and an **arrow** to represent the feeding relationship within community B.
- (d) **Explain** how human activities that add toxins to the soil could change a community with many species at each trophic level, such as community A, into a community with few species at each trophic level, such as community B.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

5. 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.

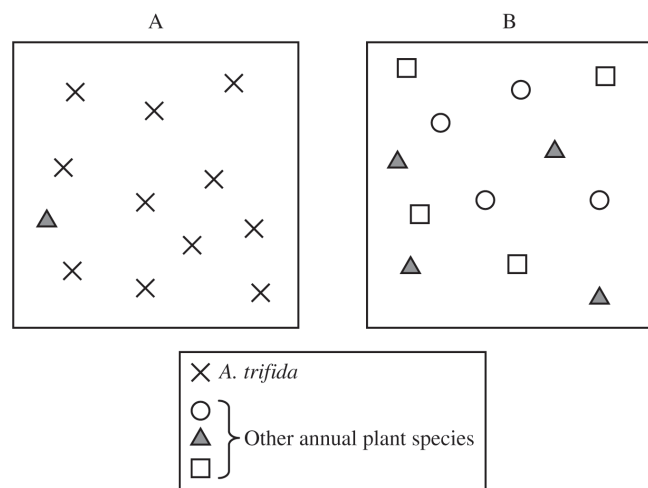


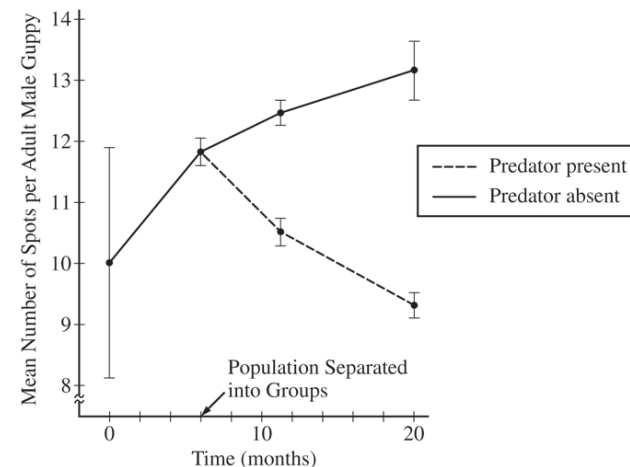
Figure 1. Representations of plant identity and distribution in experimental plots in late summer. Each box represents one typical experimental plot, and each symbol represents 10 individual plants.

- (a) **Describe** a cause of logistic growth of the ragweed population.
- (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.
- (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.
- (d) **Explain** how an invasive species such as ragweed affects ecosystem biodiversity, as illustrated in Figure 1.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

4. Adult male guppies (*Poecilia reticulata*) exhibit genetically determined spots, while juvenile and adult female guppies lack spots. In a study of selection, male and female guppies from genetically diverse populations were collected from different mountain streams and placed together in an isolated environment containing no predators.

The study population was maintained for several generations in the isolated area before being separated into two groups. One group was moved to an artificial pond containing a fish predator, while a second group was moved to an artificial pond containing no predators. The two groups went through several generations in their new environments. At different times during the experiment, the mean number of spots per adult male guppy was determined as shown in the figure below. Vertical bars in the figure represent two standard errors of the mean (SEM).



- (a) **Describe** the change in genetic variation in the population between 0 and 6 months and **provide** reasoning for your description based on the means and SEM.
- (b) **Propose** ONE type of mating behavior that could have resulted in the observed change in the number of spots per adult male guppy between 6 and 20 months in the absence of the predator.
- (c) **Propose** an evolutionary mechanism that explains the change in average number of spots between 6 and 20 months in the presence of the predator.
5. Genetically modified crops have been developed that produce a protein that makes the plants resistant to insect pests. Other genetic modifications make the crops more resistant to chemicals that kill plants (herbicides).
- (a) **Describe** TWO potential biological risks of large-scale cultivation and use of such genetically modified plants.
- (b) For each of the risks you described in part (a), **propose** a practical approach for reducing the risk.