

AP[®] ENVIRONMENTAL SCIENCE 2011 SCORING GUIDELINES

Question 1

(a) As mentioned in the article, there are several possible explanations for the increase in mountain pine beetles.

(i) Provide one reason why fire-suppression policies lead to increased beetle activity.

(1 point; only the first answer is scored.)

- Suppression leads to increased numbers of trees/more food/denser forests.
- Suppression allows weaker, more vulnerable trees that would have been weeded out by fire to survive.
- Suppression leads to less diversity of tree species, so beetles spread more quickly between trees.
- Suppression leads to equal/even-age stands of mature trees, which the beetles prefer.

(ii) Reduced winter mortality of beetle larvae is likely a consequence of global climate change. Describe TWO ways that the activities of the beetles might enhance climate change.

(2 points; 1 point for each activity. Only the first two answers are scored.)

- Less carbon dioxide is removed by trees (less photosynthesis/primary production/carbon sinks/carbon sequestration).
- Higher levels of dead tree matter release more carbon dioxide through decomposition.
- Burning of forests as a result of infestation (dead trees) releases carbon dioxide.

Note: Carbon dioxide released by beetle respiration is NOT an acceptable answer.

(b) The widespread death of trees leads to a series of changes in a forest ecosystem. Identify TWO physical changes that occur in the forest ecosystem as the result of the death of mature trees. For each physical change you identify, describe an impact of that change on the forest ecosystem.

(4 points; 1 point for each identification and 1 point for each description. The description must be LINKED to the identification. Only the first two answers are scored.)

Physical change	Impact on ecosystem
Habitat loss (loss of foliage, branches, physical structures provided by trees)	<ul style="list-style-type: none"> • Loss of biodiversity. • Loss of shelter (nesting/breeding). • Animal species migrate or die. • Loss of food. • Increased competition for food/shelter.
Increased sunlight reaching the ground	<ul style="list-style-type: none"> • Growth of younger trees because of reduced competition for light. • Shift in species because of changing light conditions. • Increased habitat for species in downed trees and/or snags. • Loss of species that cannot tolerate higher temperatures. • Increased evaporation from waterways reduces flows. • Faster evaporation of snowcover reduces snowmelt in spring and reduces flows. • Increased sunlight results in decreased snowcover.

**AP[®] ENVIRONMENTAL SCIENCE
2011 SCORING GUIDELINES**

Question 1 (continued)

Increased erosion/decreased root systems/increased runoff	<ul style="list-style-type: none"> • Loss of nutrients for plants. • Loss of root zone for plant stability. • Increased siltation/sedimentation. • Change in stream and river depth leads to changes in plant and animal species. • Changes in water clarity leads to reduced primary productivity. • Mortality of animal and plant species that are buried by sediment.
Less absorption of precipitation by trees	<ul style="list-style-type: none"> • Increased runoff. • Increased erosion. • Loss of nutrients (leaching or runoff). • Mortality of plant species (waterlogging). • Mortality or migration of animal species. • Decreased local water vapor/drier climate.
Increased flooding	<ul style="list-style-type: none"> • Loss of nutrients (leaching). • Mortality of plant species (waterlogging). • Mortality or migration of animal species.
Increased soil temperature	<ul style="list-style-type: none"> • Changes in plant growth. • Changes in soil communities (microbes and invertebrates).
Downed trees or snags	<ul style="list-style-type: none"> • Increased habitat for species. • Risk of catastrophic fires. • Increased nutrients from tree decomposition.

(c) As the article states, the number of managed honeybee colonies has dropped significantly over the past few decades. Describe TWO specific economic consequences of the collapse of the managed honeybee colonies.

(2 points; 1 point for each consequence linked to a description. Only the first two answers are scored.)

Economic consequence	Description
<ul style="list-style-type: none"> • Increased costs/prices • Lower revenue/sales • Loss of jobs 	<ul style="list-style-type: none"> • For food crops. • For beekeepers' services/replacement of hives. • For manual pollination. • For attraction of native pollinators by planting wildflowers/native flowering plants OR providing nesting sites and safe foraging areas. • For better nutrition/medicine for bees. • Because of lower crop yields. • Because of lower honey production.

**AP[®] ENVIRONMENTAL SCIENCE
2011 SCORING GUIDELINES**

Question 1 (continued)

(d) Pollination by native insects is considered an ecosystem service. Identify a different ecosystem service and explain how that service benefits human society.

(2 points; 1 point for the identification and 1 point for its linked benefit. Only the first answer is scored.)

Ecosystem service	Benefit
Control of pests with natural predators	<ul style="list-style-type: none"> • Reduces incidence of disease (vector-borne). • Reduces need for pesticides. • Reduced crop losses.
Waste disposal/treatment	<ul style="list-style-type: none"> • Decomposition reduces amount of waste. • Recycles nutrients (plant growth). • Detoxification, removal of pollutants.
Filtering/purification of water by soils and plants	<ul style="list-style-type: none"> • Reduces costs of providing safe drinking water. • Less contamination/fewer waterborne diseases.
Storage and regulation of water supplies (water cycle)	<ul style="list-style-type: none"> • Reduces costs of creating fresh water (reverse osmosis). • Supports growth of agricultural crops. • Allows transport of goods. • Allows manufacturing of goods. • Water is necessary for survival.
Disposal/dilution of fecal waste	<ul style="list-style-type: none"> • Reduced incidence of disease. • Reduced cost of sewage treatment.
Cycling of nutrients (such as nitrogen/phosphorus)	<ul style="list-style-type: none"> • Reduces use of inorganic/synthetic fertilizers. • Recycles nutrients (plant growth).
Release of oxygen by plants (oxygen cycle)	<ul style="list-style-type: none"> • Necessary for human survival.
Prevention of soil erosion (roots)	<ul style="list-style-type: none"> • Reduces costs of soil amendment/fertilizer.
Flood control and moderation of the effects of severe storms (storm surges) through absorption of water	<ul style="list-style-type: none"> • Protection of human lives. • Lower cost for loss of human property.
Lumber/timber	<ul style="list-style-type: none"> • Building, fuel, paper products. • Provides income for loggers, paper industry. • Difficult or expensive to replace/duplicate (synthetics often use petrochemicals).
Cycling of carbon	<ul style="list-style-type: none"> • Vital to crop growth. • Helps in moderation of global temperature.
Medicines to treat diseases	<ul style="list-style-type: none"> • Provides income to harvesters. • Improves quality of human life (e.g., cancer and diabetes drugs).
Genes for resistance to pathogens and crop pests	<ul style="list-style-type: none"> • Reduces costs of pesticides. • Reduces use of fossil fuels.
Fish, game, fruit, nuts	<ul style="list-style-type: none"> • Source of food for hunters, gatherers, fishers.
Soil formation, maintenance of soil nutrients	<ul style="list-style-type: none"> • Reduces costs of fertilizer/soil amendment.

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- (c) As the article states, the number of managed honeybee colonies has dropped significantly over the past few decades. Describe TWO specific economic consequences of the collapse of the managed honeybee colonies.
- (d) Pollination by native insects is considered an ecosystem service. Identify a different ecosystem service and explain how that service benefits human society.

a) i - Fire-suppression policies keep natural forest fires from occurring, allowing the trees to mature. Mature trees are the preferred food source of the beetles, so more mature trees leads to more beetles feeding on the trees.

ii - One way the beetles are affecting the climate is CO₂ levels in the atmosphere. With the trees being consumed, less photosynthesis will take place, resulting in more CO₂ and less oxygen. CO₂ is a greenhouse gas, which will increase the temperature of the planet. A second way the beetles affect the climate is in the amount of ultraviolet radiation present. With the trees and their leaves gone, more ultraviolet radiation will reach the surface and more infrared radiation will come from the ground, resulting in higher global temperature.

b) The death of mature trees leads to a loss of habitat for many species. The biological diversity of the forest will be affected in a bad way. Another physical change is that more surface runoff will occur without the mature trees. More sediments and nutrients will flow into the rivers and streams of the forest, affecting the water life.

GO ON TO THE NEXT PAGE.

1A2

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

c) One economic consequence of the loss of honeybees is that less honey will be produced, increasing the cost of honey on the market. Another economic consequence is that the honeybees will not pollinate as many crops, resulting in increased prices of farmer's goods.

d) Wetlands act as a buffer to flooding. During periods of intense rain or tidal flooding, wetlands absorb the water, preventing it from affecting human infrastructure.

GO ON TO THE NEXT PAGE.

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a) i) Often small or controlled forest fires are greatly beneficial for the environment. In this case, the lack of fires have given the Mountain Pine Beetle more trees to target. They also most likely lay their ~~eggs~~ larvae in the trees, so more are being produced, since they aren't being killed off in a forest fire.

ii) In efforts to combat the booming beetles, more pesticides are probably being used, hence more harmful chemicals/~~and~~ pollutants are being released into the atmosphere. ~~Staying~~ the chemicals from such pesticides could also eventually run-off into the ocean or lakes, evaporate, and contribute to the atmosphere pollution, making the climate warmer.

b) The death of mature trees would definitely be a loss of habitat to some species. This could cause competition for other trees (less mature) and ~~even~~ result in a species to being endangered. Another consequence is that smaller trees and plants could be more exposed to sun light, as the mature trees are no longer shading them, this could be harmful to some plants or trees that grow better in the shade, causing them to possibly die as well.

GO ON TO THE NEXT PAGE.

c) Many farmers keep honey bees as another source of income, but with the loss of colonies they would have no honey to harvest and sell. This could also ~~cause~~ effect other people as the price of honey would go up. Another problem is that ~~these~~ farmer's crops may not get pollinated as well, hence they would also have less crops to sell, resulting in more loss of income.

d) Many species feed off of insects. I ~~am~~ am particularly grateful to those (such as bats) that eat mosquitos. This is a major benefit to society, as being bitten by lots of mosquitos ~~is~~ isn't fun, and meanwhile they get food.

GO ON TO THE NEXT PAGE.

- 191
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4 a. i. Fire suppression policies lead to increased beetle activity because forest fires destroy forests, and ~~therefore~~ ^{therefore} the mountain pine beetles that inhabit them. Less fires means that these beetles could populate freely.

ii: Two ways in which the beetle's activities might enhance climate change would be providing more biomass for fuel and making soil more nutritious by breaking down the trees.

b. The death of the trees would result in physical changes in the forest such as loss of limbs and leaves on trees.

Many organisms rely on mature trees for their habitat, and their death would leave them unusable. This would call for an immediate change for many species. Additionally, the growth of underlying plants would flourish. With more resources and sunlight available in the tree's absence, this succession would take place.

c. With the collapse of managed honeybee colonies has come some economic hardship. Many food crops are dependent on pollination by honeybees. With less bees, these valuable crops cannot grow as efficiently. The honey business has slowed in production due to the drop of colonies, but a smaller supply makes the demand higher and therefore the price.

d. Bats provide an ecosystem service by serving as natural pest combatants. They feed on mosquitos, which keeps the mosquito population down without

GO ON TO THE NEXT PAGE.

1C3

ADDITIONAL PAGE FOR ANSWERING QUESTION 1

humans having to use pesticides.

GO ON TO THE NEXT PAGE.

AP[®] ENVIRONMENTAL SCIENCE 2011 SCORING COMMENTARY

Question 1

Overview

This was a question based on a mock newspaper article. The article described population changes in two species of insect, mountain pine beetles and European honeybees. Students were asked to explain how fire-suppression policies in forests encourage beetle populations, to describe how beetle activity enhances climate change, to identify what physical changes occur with the death of mature trees, and to describe how those changes impact the forest. The second part of the question required students to describe the economic consequences of colony collapse disorder (CCD) in honeybees and to identify an ecosystem service other than pollination and to explain how it benefits society.

Sample: 1A

Score: 10

This response is excellent. One point was earned in part (a)(i) for stating, as a reason why fire suppression leads to increased beetle activity, “more mature trees leads to more beetles feeding on the trees” — because suppression leads to larger numbers of mature trees in the forest. In part (a)(ii) 1 point was earned for stating that the trees are “being consumed” and thus less photosynthesis is taking place. The second reason given in part (a)(ii) did not earn a point, because it claims that more ultraviolet radiation is reaching the ground, which is not a factor that will enhance global climate change. One point was earned in part (b) for the first physical change named, “loss of habitat,” and another point was earned for describing its impact: “biological diversity of the forest will be affected in a bad way.” The second physical change identified is “more surface runoff,” which earned 1 point, and the linked impact (“[m]ore sediments and nutrients will flow into the rivers and streams”) earned 1 more point. The first economic consequence stated in part (c), “less honey will be produced, increasing the cost of honey,” earned 1 point. The second consequence, “the honeybees will not pollinate as many crops, resulting in increased prices of farmer’s [*sic*] goods” earned 1 point. One point was earned in part (d) for identifying flood control as an ecosystem service (“[w]etlands act as a buffer to flooding”), and another point was earned for explaining its benefit (“wetlands absorb the water, preventing it from affecting human infrastructure”).

Sample: 1B

Score: 8

This response is good, and the majority of the concepts are clearly expressed. One point was earned in part (a)(i) for stating that “the lack of fires have [*sic*] given the Mountain Pine Beetle more trees to target.” No points were earned in part (a)(ii) because the claim that increased pesticide use contributes to global warming is not a valid answer. One point was earned for the first physical change identified in part (b), habitat loss, and another point was earned for describing its impact (“competition for other trees”). One more point was earned for the second physical change named (“smaller trees and plants could be more exposed to sun light”), and 1 point was earned for noting its effect: a shift in species because of changing light conditions, which “could be harmful to some plants or trees that grow better in the shade.” One point was earned in part (c) for pointing out the economic consequence of having “no honey to harvest and sell,” so “the price of honey would go up.” A second point was earned in part (c) for stating that farmers “have less crops to sell, resulting in more loss of income.” One point was earned in part (d) for identifying pest control by natural predators as an ecosystem service (“[m]any species feed off of insects”), but no additional point was earned for explaining the benefit to humans, because bats’ eating of mosquitoes is not clearly linked to human health.

**AP[®] ENVIRONMENTAL SCIENCE
2011 SCORING COMMENTARY**

Question 1 (continued)

Sample: 1C

Score: 6

No point was earned in part (a)(i) because the destruction of beetles by forest fires is not an acceptable means of controlling their population. No points were earned in part (a)(ii) because the answer does not address how the beetles' activities result in an increase of carbon dioxide in the atmosphere. One point was earned in part (b) for the first physical change named ("loss of limbs and leaves on trees"), but no point was earned for explaining a related effect, because "death would leave them unusable" is not a specific impact. Another point was earned for the second physical change identified in part (b) — more sunlight being available, and 1 point was earned for describing an impact of this change ("underlying plants would flourish"). No point was earned in part (c) for the first economic consequence given, which includes vague phrases such as "economic hardship" and "crops cannot grow as efficiently." One point was earned in part (c) for the second consequence mentioned: "a smaller supply [of honey] makes the demand higher and therefore the price." One point was earned in part (d) for indicating that bats are natural predators that control pest populations, and 1 more point was earned for stating as a benefit that humans do not have to use pesticides.