AP® ENVIRONMENTAL SCIENCE
2016 SCORING GUIDELINES

Question 1

Read the following article from the *Fremont New Tribune*.

(a) Diseases can devastate populations; however, most diseases do not drive their host to extinction. **Provide** one explanation for why diseases seldom cause extinction.

(1 point for a correct explanation for why diseases seldom cause extinction)

- Genetic diversity in wild populations enables some resistant organisms to survive and reproduce.
- Disease organisms often co-evolve with their hosts, allowing the host to evolve adaptations that resist the disease.
- Disease organisms/pathogens that cause the extinction of their host population jeopardize their own survival.
- Initial deaths thin (reduce density of) populations and make the disease less likely to spread.

(b) Dr. Serach suggests that even if the impact of WNS on little brown bat populations can be reduced and the extinction of the species avoided, the bat populations are likely to remain alarmingly small.

(i) **Describe** TWO threats (other than WNS) to the survival of the bat species if the total number of bats becomes very small.

(2 points: 1 point for each description of a threat. Only the first two descriptions can earn a point.)

- Difficulty finding mates when populations are small, widely dispersed, or have a skewed sex ratio
- Competition from other species with a similar niche (e.g., nesting sites, food)
- Problems associated with a reduction of genetic diversity (small gene pool, lack of hybrid vigor, diseases that affect one will affect all members of the population, bottle-neck, etc.)
- Susceptibility to reduced fitness as a result of decreased protection by the group (e.g., not enough individuals to create heat, less protection by group members, increase in probability of becoming prey without the advantage conferred by group size)
- Increased vulnerability to environmental disturbances (need to name specific disturbance)

(ii) If the little brown bat species does not become extinct and can potentially recover, the rate of recovery is likely to be slow. **Discuss** one aspect of bat biology that might slow the recovery of little brown bat populations to pre-WNS numbers.

(1 point for a correct discussion of a correct aspect of bat biology that might slow their recovery)

- Low fecundity/ few babies per year
- Long generation times in bats
- Advanced age at first reproduction
- Increased parental care

(c) Bats are found in ecosystems around the world. **Describe** TWO ways in which other organisms in an ecosystem could be affected by a decline in a bat population.

(2 points: 1 point for each correct description. Only the first two descriptions can earn a point.)

Question 1 (continued)

- Increase in bat food sources.
- Increase in West Nile and other insect-borne diseases
- Decrease in the spread of rabies
- Decrease in fungus that causes WNS
- Decrease in bat guano (tied to organism)
- Decline in plants pollinated or dispersed by bats
- Decline in bat predators due to decreased food supply.
- Increase in numbers of animals with similar food and habitat needs
- Causes a trophic cascade

(d) The Eastern deciduous forest, in which the little brown bats live, is an important ecosystem. **Identify** TWO ecosystem services that forests provide, and **explain** how each service benefits human society.

(2 points: 1 point for each correct ecosystem service with an explanation of how the service benefits human society)

Acceptable responses may include the following:

Ecosystem Service	Benefit to Humans
Resource material (tree/forest)	Lumber, building materials, fuel, paper, food
Oxygen production	Human respiration
Soil formation/protection	Forestry, agriculture, flood control, water quality
Protection of water supplies	Drinking water, recreation, irrigation, fishing
Habitat (e.g. specify shade, temperature moderation, etc.)	Animals or plants desired by humans for fishing, hunting, food
Biodiversity	Food, medicine, gene diversity, breeding stock
Carbon sink (sequestering)	Slows climate change
Aesthetics/cultural/social	Connection with nature (inspiration for art, music, poetry, etc.), research, education, recreation, tourism

WNS is an emerging disease in bats. Humans are also subject to emerging diseases, such as Ebola. A recent study suggests that the number of emerging infectious diseases affecting human populations has been steadily increasing in recent decades.

(e) **Provide** a likely reason for the increase in emerging infectious diseases affecting human populations. Include an explanation for the reason you provided.

(2 points: 1 point for a correct reason for the increase in emerging infectious diseases. 1 point for a correct explanation of how the reason likely increases the emerging diseases affecting human populations.)

Acceptable responses may include the following:

Question 1 (continued)

Reason for Increase	Explanation
Climate change, global warming	Allows pathogens and disease vectors to survive in places that were previously too cold or dry
Increase in global travel	Increased likelihood of contracting/spreading disease
Increased exposure to animals (zoonotic)	Changes in agricultural practices increase rodents, etc; trade in exotic species, intrusion into wild habitats, urban sprawl
Increase in population density/distribution	Increased likelihood of contracting /spreading disease from others
Lack of vaccinations	Increase human susceptibility to disease, reduce herd immunity
Antibiotic resistance	New disease strains evolve
Decrease in medical care/public health	Poverty, war, migration, human behavior (refusing to use condoms/sharing needles/refusing aid)

PAGE FOR ANSWERING QUESTION 1

a.) Diseases seldom cause extinction because of genetic diversity. In every population, genetic diversity creates a different level of fitness in each individual. So, when a disease attacks a population, those who are genetically resistant to the disease will survive and pass on their resistance to the next generation. It is the uniqueness of the genotype in each individual that keeps a species alive.

b.) i) If the number of bats get very small, they can be made extinct more easily by their natural predators because if predators eat bats at the same rate as when the populations were larger, a much larger proportion of the population will be destroyed. Also, smaller populations causes genetic diversity to decrease. This means that the genotypes of individuals in the population will be much more similar and vulnerable to a second disease eradicating them completely.

ii) Bats are a K-selected species. This will slow their recovery because they have few offspring, have pups later in life, and take a lot of time to raise the pups.

c.) Insects, like mosquitos, that bats eat would increase in population due to a lack of predators. Also creatures that prey on bats would decrease in numbers due to a lack of a large enough food source.

d.) Forests provide a habitat for many different

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organism. These organisms can then be harvested or hunted for use by humans including food (animals and vegetables) and medicine (herbal remedies). Forests also create a large net primary productivity by the trees to fuel the other organisms it contains. Those trees are useful to humans by providing building materials to create things.
e.) Infectious diseases are affecting human populations more and more because we are in especially close contact with the animals. Because of habitat destruction, some animals can no longer isolate themselves from humans and must live fairly closely. So, the new close quarters with the animals increase the chance of them spreading infectious diseases to us.

1B1

(a) Diseases usually don't drive their host ~~populations~~ to extinction because within a population there is usually genetic variation, which would increase the chances of a few bats survival. Then, their disease-~~bacteria~~ resistant genes will allow these select bats to survive and reproduce.

(b) Most people are afraid of bats because it is widely circulated that they carry infectious diseases, so humans purposefully kill them. ~~#~~ Also, ~~Some~~ fruit farmers often kill off bats because the bats eat their fruit, which lowers the farmers' profits.

Bats lean towards a K-selective species mindset. They reproduce rather slowly (only 1-2 pups per year) and they are starting with a smaller population. They focus on high parental care (instead of quantity) ~~so~~ so that their pups survive.

(c) ~~Bats bridge the gap between the cave ecosystem and the outside world ecosystems~~

Bats help keep insect populations under control, so a decline in the bat population would lead to an ~~explosion~~ spike in the insect population. Bats can also act as pollinators, so fewer ~~flowers~~ plants could reproduce.

(d) Forests are essential absorbers of CO_2, which helps counteract human production of CO_2, therefore decreasing

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global warming. Forests also serve as habitats for a wide variety of animals, which hold economic (hunting and food) value and deep intrinsic value for human society.

(e.) Emerging infectious diseases in the human population are likely increasing because we are becoming more population dense and could be approaching our species carrying capacity. Disease is a density-dependent factor, so the more people in a population, the easier it is for disease to spread in order to control the population.

1C

(A) Disease doesn't always drive species to extinction because there are always members of the species that won't be effected by the disease. And through evolution, the species may no longer be effected by the disease, after a certain amount of time.

(B) i) Humans are a threat to the survival of bat species because humans are taking away their natural habitats forcing them to try and find a new home. Other predators are also a threat because they hunt the bats to help their own species survive.

ii) The ratio of males and female bats could affect the rate of recovery because there needs to be both a male and female to reproduce.

(C) Bats are known for eating insects, so if the bat population decreases the insect population will increase, causing an imbalance. Predators of bats will decrease if the bat population decreases because the predators will have less food.

(D) Forests provide humans with lumber, which can be used for building houses or for making paper, both things that humans need. Forests also provide an anchor for the soil, which helps humans because the

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loose soil could end up contaminating river, making humans sick.

(E) Infectious diseases are emerging because of the increase in average global temperature, which is allowing disease to spread to places that it couldn't before. For example, mosquitos, which can cause malaria, are now able to travel all around the world, spreading malaria.

AP® ENVIRONMENTAL SCIENCE
2016 SCORING COMMENTARY

Question 1

Overview

The intent of this question was to test a student's ability to synthesize and evaluate problems in population and ecosystem biology/ecology and emerging infectious diseases. Although the Fremont Press article discussed many aspects of the little brown bat, this question was less about bats and more about the impacts of small and declining populations.

The first part of the question asked students to provide an explanation for why a disease, such as White Nose Syndrome (WNS), seldom causes extinction of its host species. The next few parts ask how the surviving bat populations respond to their small number and size. In part (b) students were asked to describe two threats to the species' survival, given the very small population size. They are then told that recovery of this small population will be slow and are asked to discuss one aspect of bat biology that contributes to this slow recovery time. In part (c) students were asked to describe how a decline in the bat population affects other organisms in an ecosystem. In part (d) students were asked to identify two ecosystem services that forests provide, and to explain how each service benefits human society. The final part expands on the idea of a disease's impact on a population. In part (e) students were asked to provide a correct reason and explanation for the increase in emerging infectious diseases that are affecting human populations.

Sample: 1A
Score: 10

One point was earned in part (a) for providing an explanation that demonstrates how disease seldom causes extinction "because of genetic diversity." Those individuals that "are genetically resistant" will be able to "survive and pass on their resistance" to the next generation. Two points were earned in part (b)(i) for describing "if predators" eat small bat populations at the "same rate as when populations were larger, a much larger proportion of the population will be destroyed," and for considering genetic diversity, as bats with a small population will have "genotypes of individuals in the population" that will be "more similar and vulnerable to a second disease." One point was earned in (b)(ii) for a discussion on one aspect of bat biology as "Bats are a K-selected species. This will slow their recovery because they have few offspring." Two points were earned in part (c) for describing two examples of how other organisms could be affected by a decline in a bat population. The first for "Insects, like mosquitos … would increase" and the second point was earned by stating "creatures that prey on bats would decrease." Two points were earned in part (d) for identifying the correct ecosystem service such as providing "habitat for many different organisms" along with a linked explanation of this benefit to humans, in this case how those organisms could be used for "food," and for identifying another ecosystem service such as providing "trees," which is linked to humans using them for "building materials." Two points were earned in part (e) by providing a reason that emerging infectious diseases "are affecting human populations more" because habitat destruction brings animals and humans closer as animals "can no longer isolate themselves from humans." As a result of "close quarters with animals," there is an increase in "them [animals] spreading infectious disease."

Sample: 1B
Score: 8

One point was earned in part (a) for explaining how "genetic variation" allows for "disease-resistant genes" in individuals that then "survive and reproduce." No points were earned in part (b)(i) as the threat that was presented was not density-dependent. One point was earned in (b)(ii) as these species are K-selected and "reproduce rather slowly." Two points were earned in part (c) for describing how the bats' decline helps "lead to a spike in the insect population," and how bats are "pollinators" so that "fewer plants could reproduce."

Question 1 (continued)

Two points were earned in part (d) for identifying how "forests are essential absorbers of CO_2," which helps humans by "decreasing global warming," and for identifying how the forests provide "habitats," which humans use for "hunting and food." Two points were earned in part (e) by providing the reason for population density increasing and for a correct explanation of how that density can make it easier "for the disease to spread."

Sample: 1C
Score: 6

No points were earned in part (a). No points were earned in part (b)(i) or (b)(ii). Two points were earned in part (c) for describing how as "bat population decreases the insect population will increase" and for how "predators of bats will decrease." Two points were earned in part (d) for identifying how "forests provide humans with lumber" and for identifying how forests act as an "anchor for the soil," which benefits humans by preventing the contamination of rivers. Two points were earned in part (e) by providing the reason for an "increase in average global temperature" and for showing how this allows for diseases "to spread to places it couldn't before."