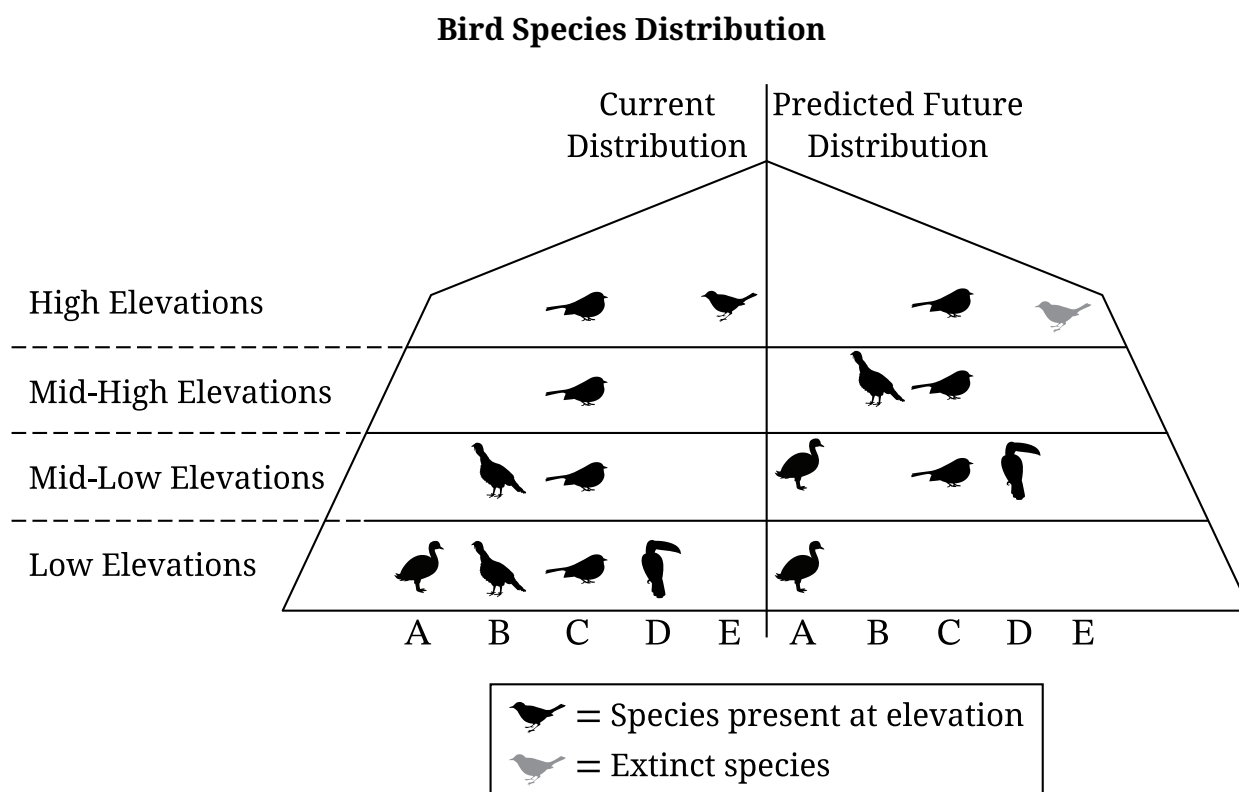


The following information applies to parts A, B, C, D, and E.

Climate change can affect both terrestrial and marine organisms. Researchers studying the effect of climate change on bird distribution mapped elevation zones at which five bird species lived within a tropical mountain range. Birds are distributed in part according to climate-related adaptations. Researchers modeled where the birds would most likely live in the future based on climate change predictions.

The results of this study are shown in the following diagram. Each unique shape in the diagram represents a different bird species, labeled A through E. Current distribution is shown on the left side of the figure, and predicted future distribution is shown on the right.

**The following information applies to parts F, G, and H.**

Some organisms such as birds can move in response to environmental changes, while other organisms such as corals cannot. Researchers studying the effect of climate change on marine organisms conducted two experiments involving photosynthetic algae that have a symbiotic relationship with corals.

In Experiment 1, the researchers placed photosynthetic algal colonies living in corals in three different saltwater tanks. The temperature of Tank 1 was set to 27°C, the average temperature at which most corals live. Water circulation in each tank mimicked natural ocean currents. After 30 days, the researchers counted the number of bleached corals. The tank setups are shown in the following list.

- Tank 1: 27°C and no sediment
- Tank 2: 32°C and no sediment
- Tank 3: 37°C and no sediment

In Experiment 2, the researchers used the same photosynthetic algae living in corals but modified the conditions of the tanks as shown in the following list. Water circulation kept the sediment in the tanks suspended. After 30 days, the researchers counted the number of bleached corals.

- Tank 1: 27°C and no sediment
- Tank 2: 27°C and moderate sediment
- Tank 3: 27°C and high sediment

1. Respond to parts A, B, C, D, E, F, G, H, I, and J.

Part A

Based on the information in the diagram, **identify** the elevation zone that has the highest species richness for the current distribution.

Part B

Describe a climate condition at high elevations that is different than it is at low elevations.

Part C

A predator at low elevations currently feeds on Species C and D. Based on the information in the diagram, **describe** what could happen to the predator species in the future in response to the predicted changes in the prey community.

Part D

Species C is considered a generalist, while Species E is considered a specialist. **Explain** why Species C and E are predicted to respond differently to climate change.

Part E

Based on the information in the diagram, **explain** why the bird community at low elevations in the future would be less likely to recover from natural disruptions than the current low-elevation bird community.

Part F

Identify the independent variable in Experiment 1.

Part G

Identify a likely scientific question for Experiment 1.

Part H

In Experiment 2 the temperature of the tanks was held constant, while the amount of sediment was varied. **Explain** how this modification could affect the results of this experiment.

Part I

Changes in climate also affect Arctic ecosystems. One impact of climate change is the loss of ice and snow in polar regions. **Describe** a positive feedback loop that results from the loss of ice and snow in polar regions.

Part J

Describe one problem that Arctic species, such as polar bears or ringed seals, face because of warming in polar regions.

Chickadees are a K-selected species of bird that eat insects and spiders. Spiders consume insects, and many insects consume plants as shown in the following food chain.

Plants → Insects → Spiders

Chickadee habitat includes forests and residential yards. Residential yards often contain nonnative plants, which do not naturally exist in an area, but were introduced by humans.

Scientists measured the average number of insects and spiders as related to the percentage of nonnative plants (Figure 1). The scientists also measured the chickadees' average population growth rate (Figure 2) to determine the impact of nonnative plants on chickadee populations.

Figure 1. Percentage of Nonnative Plants and Average Number of Individual Spiders and Insects

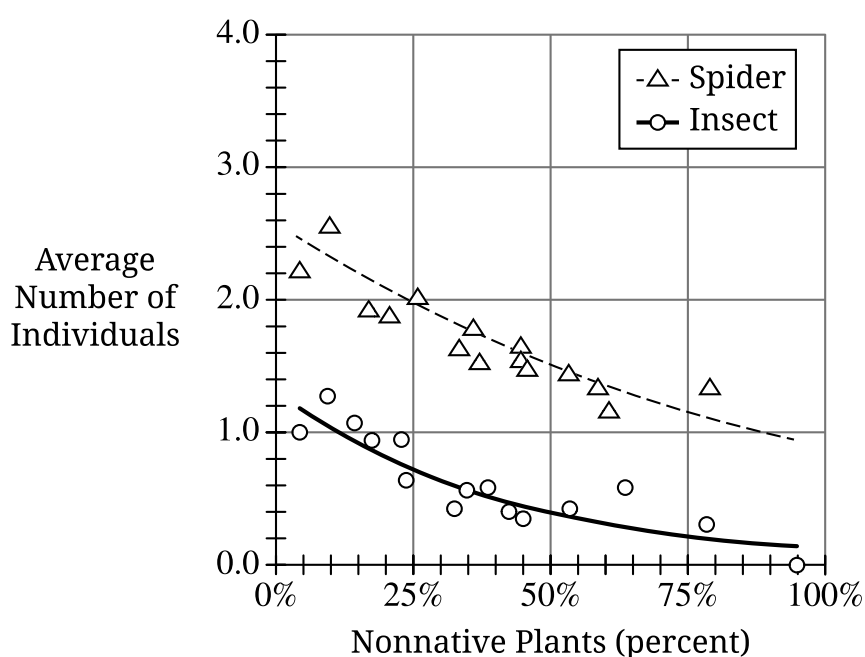
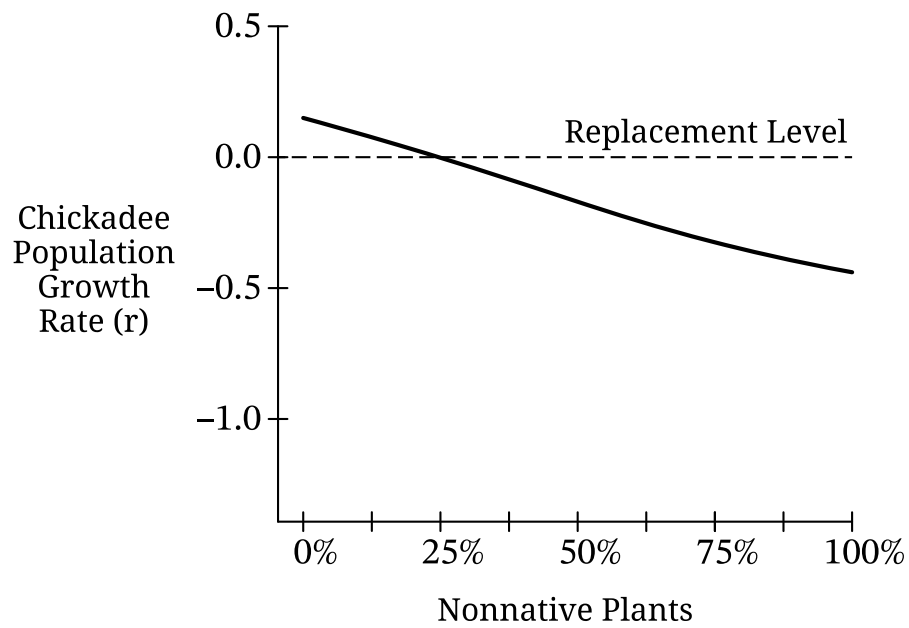


Figure 2. Chickadee Population Average Growth Rate and Percentage of Nonnative



1. Respond to parts A, B, C, D, E, F, G, and H, and all subparts.

- A. **Describe** one reproductive strategy used by a K-selected species such as the chickadee.
- B. Based on the information provided, **explain** how a decrease in spider populations could affect a lower trophic level.
- C. Based on the data in Figure 1, **identify** the number of spiders per sample at 25% nonnative plants.
- D. Based on the data in Figure 1, **describe** the trend in the number of insects per sample in relation to the percentage of nonnative plants.
- E. Scientists hypothesized that the population of chickadees would be stable or growing with fewer than 25% nonnative plants. **Describe** one way that the data in Figure 2 support this hypothesis.
- F. Insect biodiversity is important to maintain ecosystem health. A group of students was interested in learning about factors that affect ant biodiversity. They located two study sites near their school: a frequently mowed urban park and an unmowed grassland. The students used traps designed to collect ants. They loaded 10 of these traps with the same food and placed them randomly at different locations within each site. Students collected the traps after 24 hours and counted the number of different ant species in each trap to determine species richness.
- Identify** a likely scientific question for the students' investigation of ant diversity.
 - Identify** the dependent variable in the students' investigation.
- G. The data from the student investigation of ant diversity are shown in the following table. An "X" in the table indicates that the species was present at that site.

Ant Species Present in an Urban Park and Unmowed Grassland

Site	Species A	Species B	Species C	Species D	Species E	Species F
Urban park	X			X	X	
Grassland	X	X	X	X		X

- Explain** why the ant community of the unmowed grassland would be more likely to recover from a disturbance, such as a flood or fire, than the ant community in the mowed urban park would.
 - Explain** how the results of the investigation could have been altered if students had measured ant biodiversity at a paved playground rather than in the grassland.
- H. Habitat fragmentation has impacts on a variety of species. Paved roads can lead to habitat fragmentation.
- Describe** one effect that a paved road in a forest can have on animal species such as deer or bears.

There is a natural climate phenomenon that occurs in the equatorial Pacific Ocean because of periodic fluctuations in sea surface conditions and atmospheric circulation. This phenomenon happens every few years, resulting in shifts in temperature and precipitation in many parts of the world.

Figure 1 shows temperature and precipitation patterns associated with one phase of this phenomenon in the equatorial Pacific Ocean. Figure 2 shows the associated temperature and precipitation patterns that occur over North America.

Figure 1. Effects of Changes in Sea Surface Conditions in Equatorial Pacific Ocean

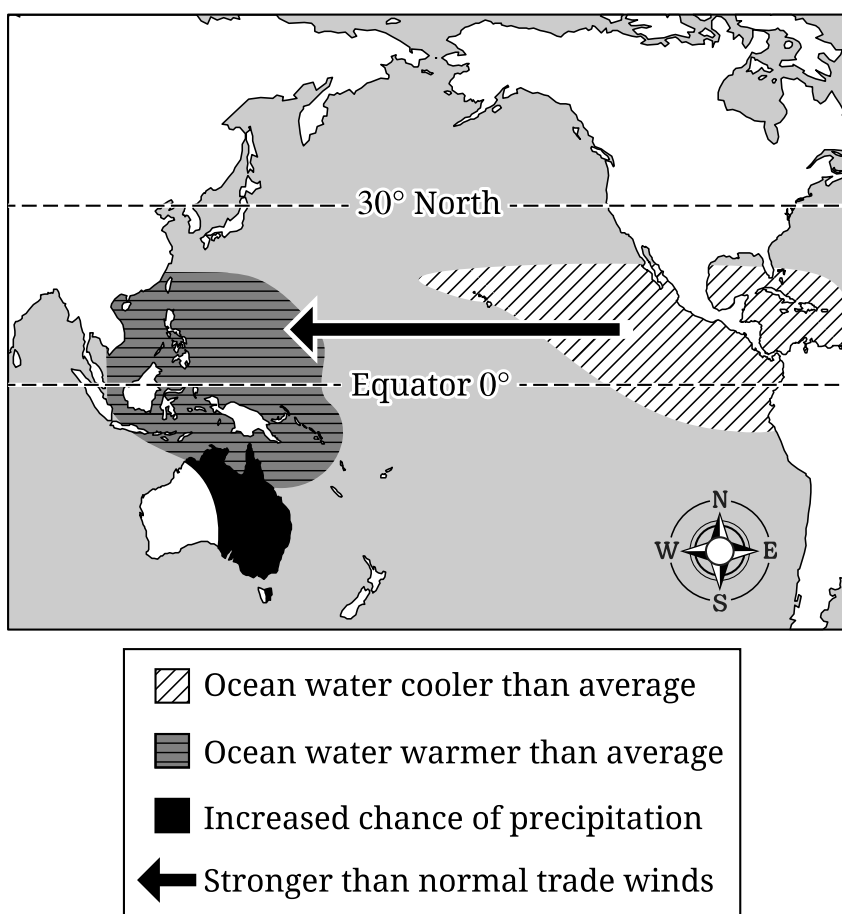
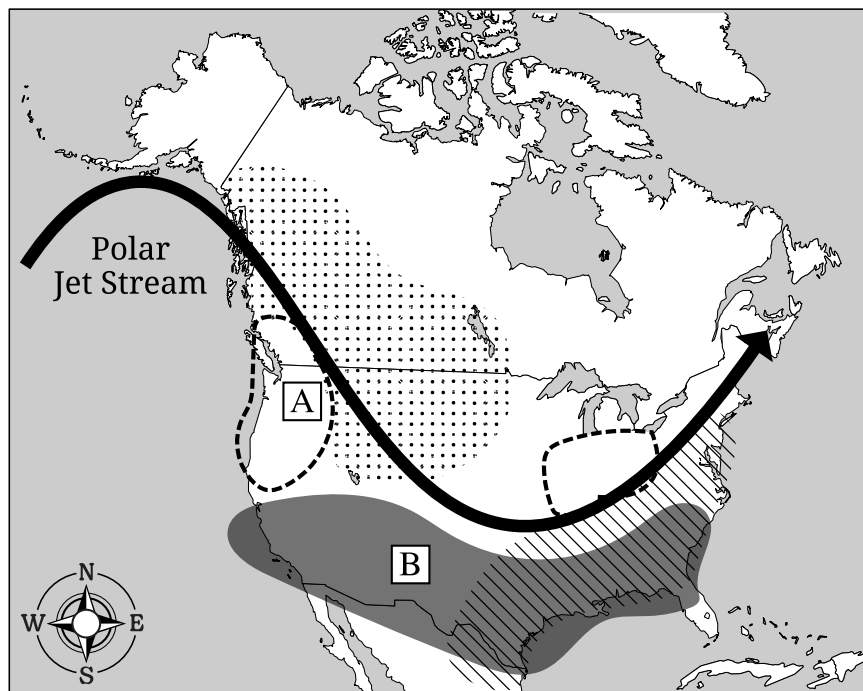


Figure 2. Polar Jet Stream and Climate Conditions in North America

-  Increased chance of precipitation
-  Decreased chance of precipitation
-  Cooler than average
-  Warmer than average

1. Respond to parts A, B, C, D, E, F, G, H, and I, and all subparts.

- A. Based on the data in the graph, **identify** the number of Common Tern breeding pairs in 1995.
- B. Based on the data in the graph, **describe** the trend in the number of Common Tern breeding pairs from 1995 to 2008.
- C. A group of students hypothesized that sea level rise will lead to an increase in Common Tern populations. **Describe** one way that the data in the graph refute this hypothesis.
- D. **Explain** how climate change can lead to sea level rise.
- E. Wading birds are a group of large-bodied birds that inhabit coastal wetlands all over the world. Researchers monitored the number of wading bird species at four coastal locations experiencing rising sea levels over a 5-year period. The data are shown in the following table.

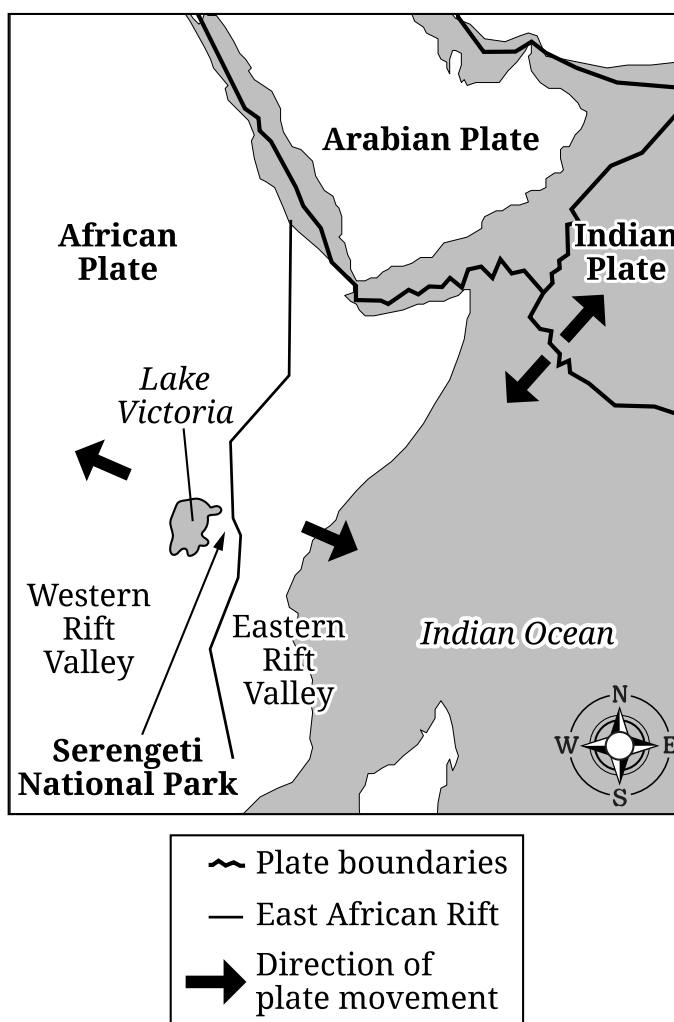
Sea Level Rise and Number of Wading Bird Species at Four Coastal Locations

Year	Increase in Sea Level (m)	Location A	Location B	Location C	Location D
1	0.05	1	5	3	4
2	0.08	2	4	3	6
3	0.10	6	7	5	5
4	0.12	5	7	7	7
5	0.15	7	8	9	8

- i. **Identify** a hypothesis that researchers are likely investigating in the wading bird study.
- ii. **Identify** the dependent variable in this study.
- F. One year after the completion of the study of wading bird species described in Part E, locations A and B experienced an increase in the concentration of PCBs, known to be a persistent organic pollutant, running off into the water.
If the researchers repeated their study, **explain** how this environmental change could affect the results of the study.
- G. **Describe** a regulating ecosystem service that can be provided by wetlands.
- H. Since 1990, there has been an increase in urbanization around the coastal wetlands that wading bird communities inhabit. Most of these bird species eat fish and locate prey visually while walking through shallow water. An increase in sediment was discovered in a wetland located near an urban area.
Explain how increased sediment might lead to a change in the size of the wading bird populations.
- I. **Describe** an environmental problem, other than an increase in sediment, that can occur in wetlands that is associated with increased urbanization and development.

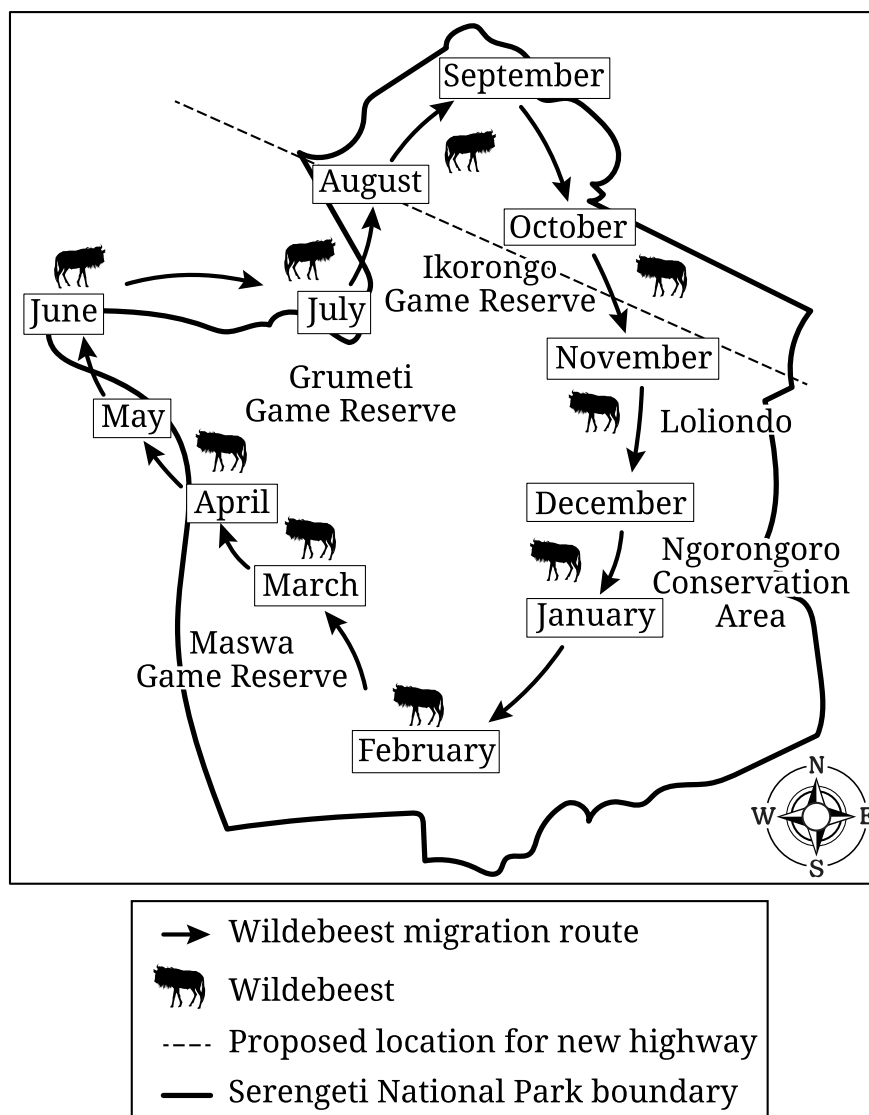
Serengeti National Park is located in Tanzania, Africa. The park is located in a valley along a tectonic plate boundary called the East African Rift. Figure 1 shows the East African Rift and other plate boundaries near the east coast of Africa.

Figure 1. Tectonic Plate Movement near East Coast of Africa



Serengeti National Park contains a variety of tropical habitats but is dominated by wideopen lands that include a variety of grass species with scattered trees and shrubs. Most grass growth occurs after the March through May rainy season. Many of the park's herbivores, such as wildebeest and zebra, migrate through the park in an annual cycle following the growth of new grass (Figure 2).

Figure 2. Annual Migration of Wildebeest in Serengeti National Park



ENVIRONMENTAL SCIENCE

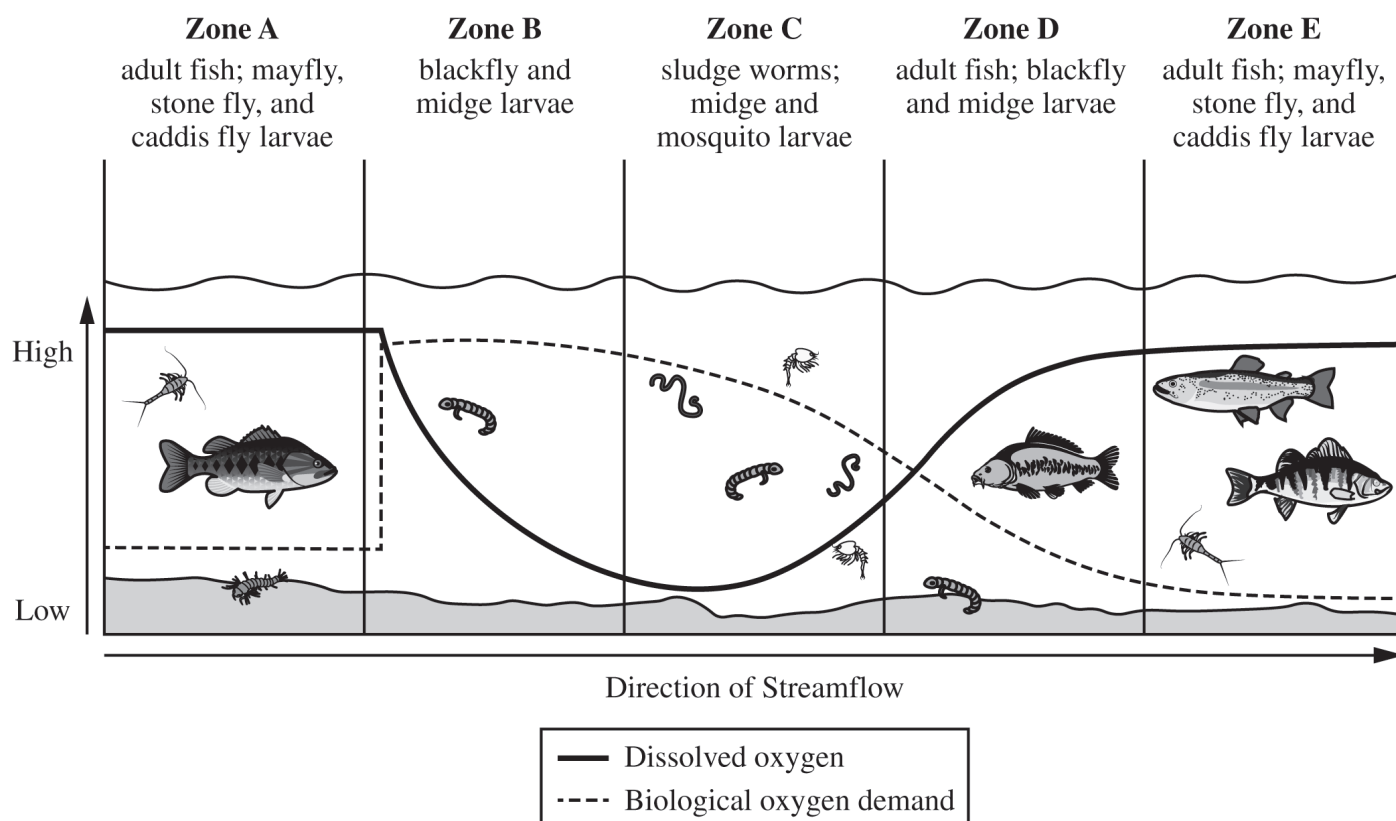
SECTION II

Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Researchers are studying the stream ecosystem shown in the following diagram. They have identified five different zones based on the dissolved oxygen levels and biological oxygen demand as the water flows downstream. Biological oxygen demand is the amount of oxygen needed by bacteria and other microorganisms to break down organic material in water. Some of the most common fish and macroinvertebrate species found in each zone are listed in the diagram.

Dissolved Oxygen and Biological Oxygen Demand in a Stream Ecosystem

- (a) Based on the information in the diagram, **identify** the zone with the lowest level of dissolved oxygen..
- (b) Based on the information in the diagram, **describe** the relationship between biological oxygen demand and dissolved oxygen.
- (c) Based on the information in the diagram, **identify** the zone where there is most likely point-source water pollution discharged into the stream.

The research team is interested in investigating the relationship between dissolved oxygen levels and macroinvertebrate species richness in the stream. Researchers counted the number of macroinvertebrate species in zones A, B, and C during the summer months. The researchers selected zone A to serve as the control in the investigation.

- (d) **Identify** the dependent variable in the researchers' investigation.
- (e) **Identify** a testable hypothesis for the researchers' investigation.
- (f) **Describe** the reason the researchers selected zone A to serve as the control in the investigation.

The researchers decided to repeat their data collection during the winter months.

- (g) **Explain** how the modification to collect data in the winter months could alter the results of the investigation.

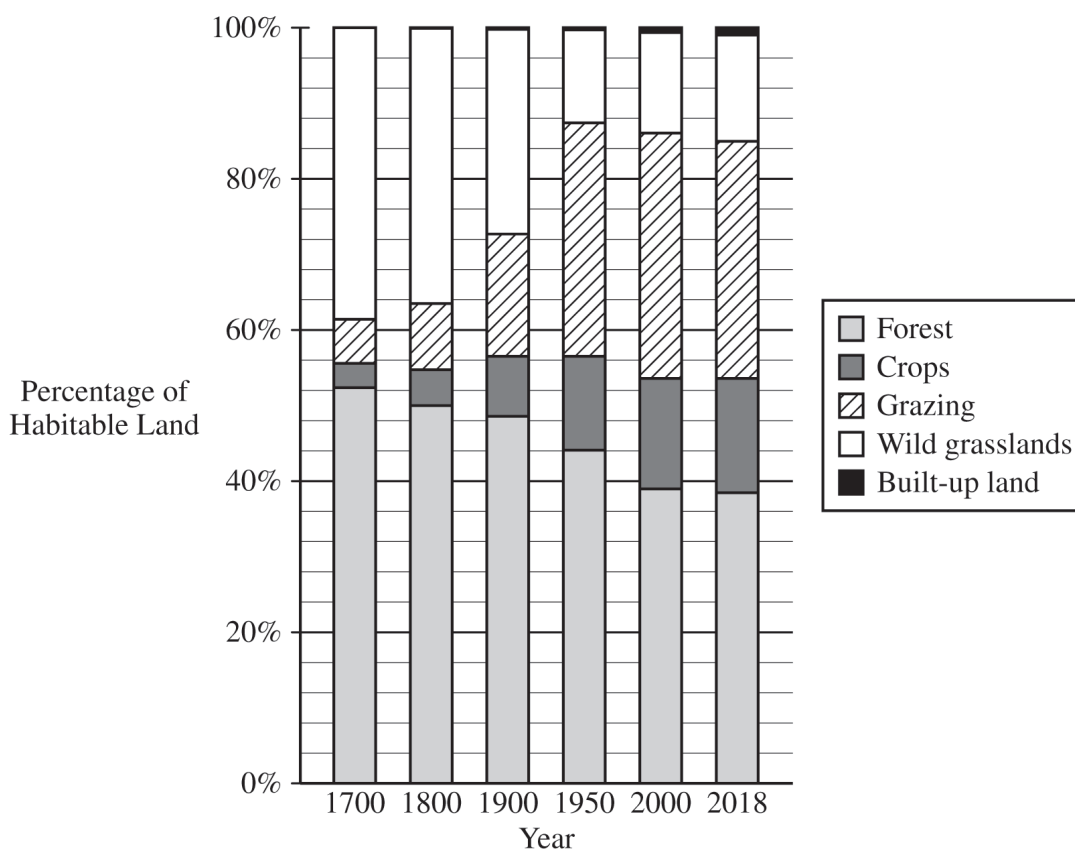
Stream ecosystems are affected by point-source organic pollution in a variety of ways.

- (h) **Describe** the effect that the introduction of raw sewage into the stream could have on the population of bacteria in the stream.
- (i) **Identify** an abiotic factor other than dissolved oxygen and organic pollution that could also influence the population size of bacteria in the stream.
- (j) **Explain** how persistent organic pollutants can affect higher trophic levels in an aquatic food web.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

2. The following graph shows how global uses of habitable land have changed since 1700.

Land Use Changes on Earth, 1700–2018



- (a) Based on the data in the graph, **identify** the year with the highest percentage of forest.
- (b) Based on the data in the graph, **describe** the relationship between the land use changes in the wild grasslands and grazing from 1700 to 1950.
- (c) **Identify** an environmental problem associated with overgrazing by livestock.
- (d) A student hypothesized that the change in the percentage of forest from 1700 to 2018 has decreased atmospheric carbon dioxide concentrations. **Explain** whether the hypothesis is supported or refuted based on the data in the graph.

Urban environments have accounted for an increasing percentage of land use within the last few decades.

- (e) **Describe** a water-related environmental problem associated with urbanization.
- (f) **Describe** a potential response to mitigate the environmental problem identified in part (e).

Farmers who own large sections of cropland notice that bobcats, a medium-sized predatory forest cat, were present many years ago but are now virtually absent in the area. Instead, smaller mammal species now inhabit the area. Over time, the farmers have cleared nearly all of the forest on their property and converted it to farmland.

(g) **Explain** why there are fewer bobcats present on the farmland now compared to several decades ago.

The small mammal species are considered pests by the farmers. The farmers partner with a conservation group to increase the number of bobcats in the area. As a solution, the conservation group will introduce bobcats onto the few isolated patches of the original forested habitat left in the area. They can introduce only a small number of bobcats in each patch.

(h) **Describe** a disadvantage of introducing only a small population of bobcats.

(i) **Propose** a solution to improve the chances that the bobcat reintroductions will be successful in reestablishing wild populations.

(j) **Justify** the solution proposed in part (i) by describing an additional advantage, other than reestablishing the bobcat population near the farms.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

ENVIRONMENTAL SCIENCE

SECTION II

Time—1 hour and 10 minutes

3 Questions

Directions: Answer all three questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers in the Free Response booklet. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. You may plan your answers in this orange booklet, but no credit will be given for anything written in this booklet. **You will only earn credit for what you write in the separate Free Response booklet.**

1. Researchers interested in sustainability developed three new varieties of genetically modified green beans designed to produce higher yields in arid regions. Four plots (A–D) were set up on a floodplain of a river to grow beans. Plots A, B, and C were each planted with seeds of different types of genetically modified strains of green beans. Plot D was planted with seeds of unmodified green beans. Each plot was given equal amounts of fertilizer, which contains phosphorus and nitrogen, and water and was irrigated using spray irrigation for one hour per day. Throughout the growing season, researchers measured the amount of green beans harvested within each plot. The plots with genetically modified beans had higher crop yields than the plot with unmodified beans.

- (a) **Identify** the control group in this experiment.
- (b) **Identify** the scientific question for the investigation.
- (c) Researchers repeated the experiment by modifying the length of time for the spray irrigation to 20 minutes per day. **Explain** how the results of the experiment could be altered with this modification.

Researchers also monitored the amount of sediment and fertilizer washing into the river from each plot in the original study. The soil temperature was also measured in each plot at the same depth and at the same time each day approximately 0.05 meters below the surface of the soil.

Genetically Modified Green Bean Experimental Results

Plot	Sediment Runoff (mg/L)	Phosphorus Runoff (mg/L)	Nitrogen Runoff (mg/L)	Soil Temperature (°C)
A (Type 1 GMO beans)	2.4	0.11	1.07	18.6
B (Type 2 GMO beans)	2.1	0.02	0.56	18.3
C (Type 3 GMO beans)	0.9	0.04	0.68	18.3
D (Unmodified beans)	3.5	0.15	1.24	17.6

- (d) Based on the data in the table, **identify** the plot with the lowest soil temperature.
- (e) **Describe** how sediment runoff and fertilizer runoff compare between the unmodified green beans and the genetically modified green beans.

- (f) The Type 2 GMO beans in Plot B were developed to grow more quickly than the unmodified beans in Plot D. Researchers have hypothesized that the Type 2 beans would use fertilizer more completely than the other varieties. Based on the data in the table and the experimental design, **explain** whether the researchers' hypothesis was supported or refuted.

Once the experiment was concluded, the researchers burned the plots to remove the crops that had been planted. After a few years, the researchers returned to the plots and observed a variety of plants, insects, and bird species living there.

- (g) **Describe** the ecological process that occurred on the plots after the crops were burned.

A survey indicated that one of the plots had twice the plant diversity that the other plots had. Over the next five years, the river occasionally flooded the plots, killing off many of the species that inhabited the plots.

- (h) After each flooding event, the plot with twice the plant diversity returned to its prior level of biodiversity more quickly than the other plots did. **Explain** why a community with more plant diversity will recover more quickly from the flooding.
- (i) After the last flooding event, a beetle not previously known in the area appeared in one of the plots with less plant diversity. Over a period of a few months, the new beetle population increased, whereas the existing beetle species in the plot had declining populations. **Explain** why the new beetle species could be better able to successfully populate this plot than the existing beetle species could.
- (j) **Describe** one realistic method to prevent the new beetle from spreading beyond the experimental plot.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

3. Habitat destruction and fragmentation can have many different effects on species.

- (a) **Describe** a characteristic of a specialist species that would make the specialist species more likely to be negatively affected by habitat fragmentation than a generalist species.

A rapidly growing suburban municipality purchases nearby forested land and proposes a newly planned housing development, which would involve clear-cutting much of the area for the construction of single-family homes. While evaluating the land, the development committee discovers that development will encroach upon the habitat of a wood thrush population. The wood thrush is a solitary, territorial bird whose preferred habitat consists of large, intact densely forested areas. Wood thrush populations are also threatened by cowbirds. A cowbird lays her egg in an existing nest of a wood thrush. After the cowbird egg hatches, the cowbird pushes the unhatched wood thrush eggs out. The wood thrush parents raise the cowbird hatchling as their own.

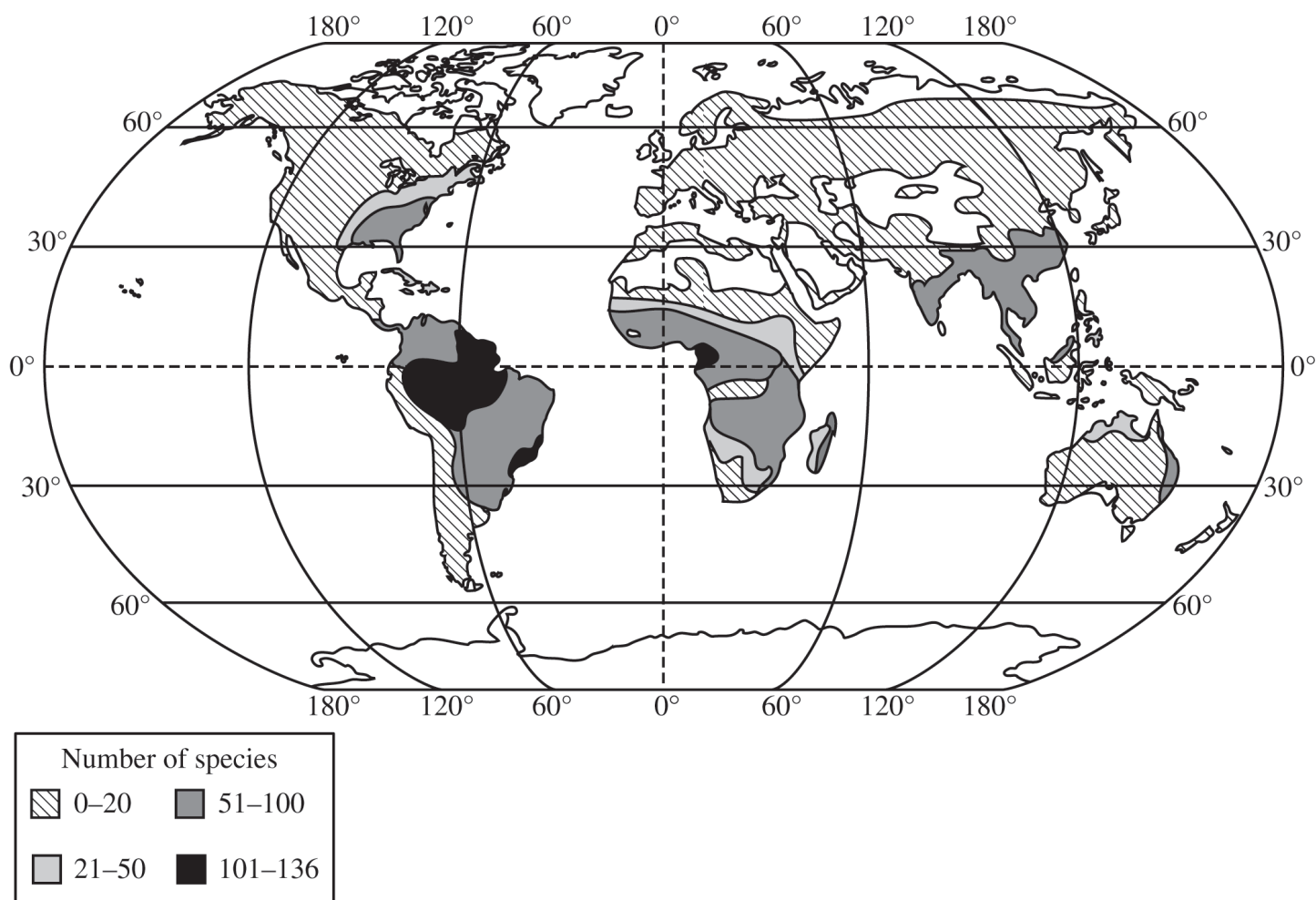
- (b) **Identify** the symbiotic relationship between the wood thrush and the cowbird.
- (c) **Describe** one ecological advantage of leaving areas of undeveloped forest in the development plan as compared to clear-cutting the property.
- (d) **Propose** a solution that will minimize the effect of development on the resident population of wood thrush while still meeting the municipality's need for a housing development.
- (e) A male wood thrush needs a minimum of 800 m^2 of territory for reproduction. The municipal development committee has set a biodiversity preservation target of 275 male wood thrush territories. **Calculate** the area that must be set aside to support the goal of 275 male thrush territories. **Show** your work.
- (f) A real estate developer wants to build houses on the property. The plan will support 1,000 lots with a lot size of $1,100 \text{ m}^2$. The developer has proposed setting aside land equal to 10% of the size of each lot it sells. **Calculate** the maximum number of male wood thrush territories that could be created under this proposal. **Show** your work.
- (g) **Calculate** the percentage of each of the 1,000 lots that would need to be set aside in order to support the goal of 275 male wood thrush territories. **Show** your work.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

STOP

END OF EXAM

GLOBAL AMPHIBIAN SPECIES RICHNESS



2. Biodiversity around the world is changing as a result of anthropogenic influences.

(a) The map represents species richness of amphibians around the globe. Use the map to answer the following questions.

(i) **Identify** the latitudinal range with the greatest amphibian species richness.

(ii) **Identify** what biome this range most likely represents.

(iii) **Describe** one reason amphibian species richness would tend to be highest in this region.

(b) There are many environmental threats facing amphibians today, such as deforestation. **Describe** one possible anthropogenic reason for deforestation.

(c) Many factors influence biodiversity.

(i) **Explain** how the species richness of an ecosystem influences its response to environmental stressors.

(ii) **Explain** why amphibian biodiversity is declining globally, other than from deforestation.

(d) Currently, wildlife species are going extinct at an alarming rate. To combat this threat, governments around the world have enacted legislation and signed treaties to protect species threatened by extinction.

- (i) **Identify** one specific piece of legislation that has been designed to protect species threatened by extinction.
- (ii) **Explain** how the requirements of the legislation identified in part (d)(i) specifically protect species threatened by extinction.
- (e) A town is considering selling an undeveloped parcel of land along its border for residential developments. The square parcel of land consists of approximately 30% wetland and 70% pasture. The wetland runs through the middle of the property for its entire width and is home to three native frog species.
- (i) **Propose** a viable solution that will result in the protection of the native frog species while still allowing for maximum profit of the property development.
- (ii) **Justify** the solution proposed in (e)(i) by describing a potential advantage of the plan, other than frog protection.

Begin your response to this question at the top of a new page in the separate Free Response booklet and fill in the appropriate circle at the top of each page to indicate the question number.

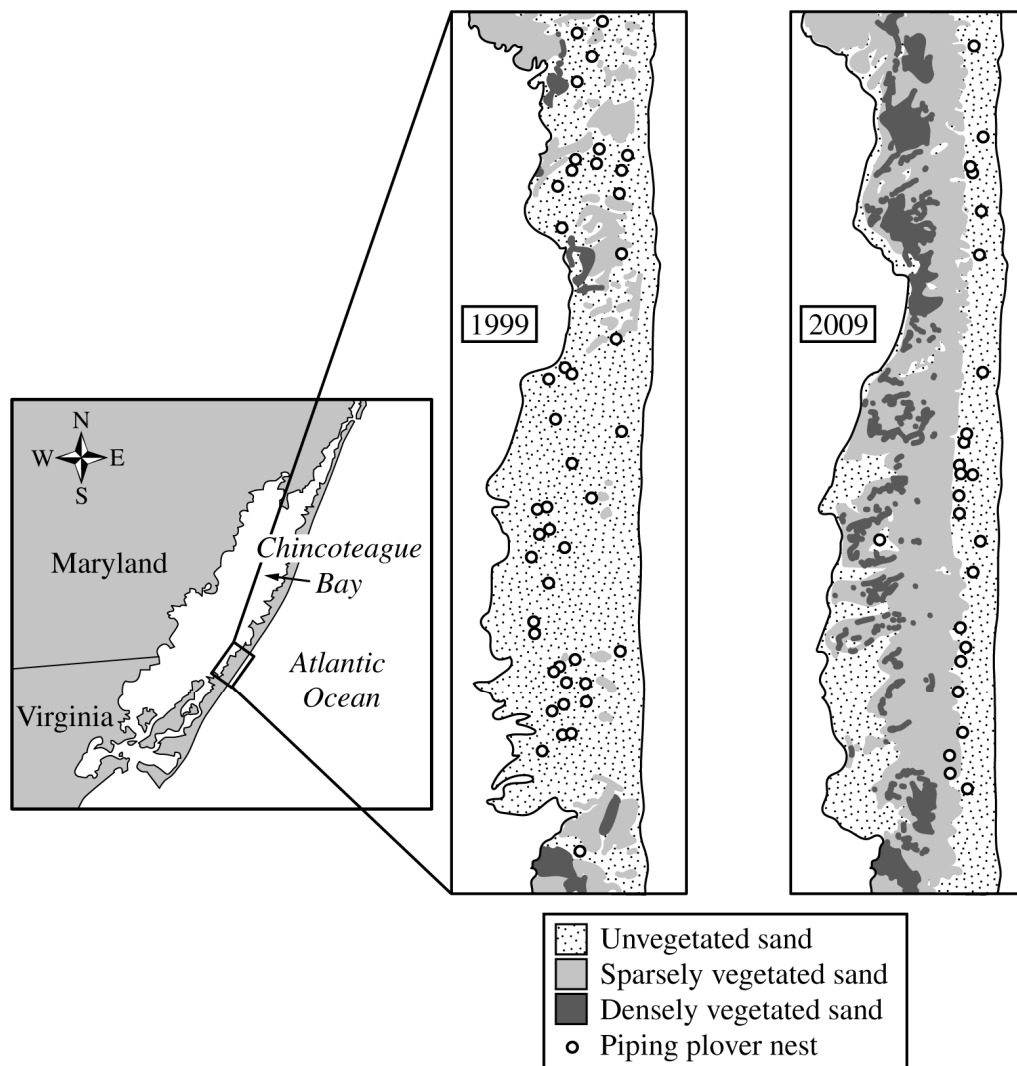
ENVIRONMENTAL SCIENCE**SECTION II****Time—1 hour and 30 minutes****4 Questions**

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this book. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

1. The piping plover is a globally threatened species, with perhaps as few as 2,000 nesting pairs remaining in the Atlantic population of these migratory shorebirds. Plovers were nearly hunted to extinction in the nineteenth century.

Plovers prefer to nest and search for food on open sandy beaches between sparsely vegetated sand dunes. Washovers, where sand is washed up from the beach and buries vegetated areas during big storms, are also important to plovers because they provide moist and undisturbed habitat for plover adults and their chicks. Ecologists with the Elliott Oceanographic Institute mapped the distribution of plover nests during two seasonal surveys of nesting sites over a ten-year period on Assateague Island. This is a barrier island, a long, narrow island running parallel to the Atlantic coast of Virginia.

**SPRING PIPING PLOVER NESTING SITES
ON ASSATEAGUE ISLAND, VIRGINIA**



- (a) Use the maps provided to answer the following questions.
- (i) **Identify** the preferred nesting habitat for piping plovers.
 - (ii) **Describe** the change in the number of piping plover nests on Assateague Island between 1999 and 2009.
 - (iii) **Describe** one likely reason for the change in the number of piping plover nests between 1999 and 2009.
- (b) Coastal species are affected by more than just natural events.
- (i) Special beach restrictions can help piping plovers during nesting season. **Describe** one restriction that could reasonably be implemented to help prevent the destruction of plover nests by human actions.
 - (ii) In addition to providing habitat for piping plovers, barrier islands (and closely related landforms) are important for other reasons. **Explain** one way that these features help to preserve and protect the environment in coastal regions.
 - (iii) **Identify** one human action that directly threatens coastal habitats and **describe** one impact on species, other than the piping plover, that use the habitat.

Approximately 40% of the United States population resides in coastal areas, such as areas near Assateague Island, where sea level rise and shoreline erosion is occurring.

- (c) **Identify** one economic impact on coastal communities that has resulted from rising sea levels.
- (d) **Describe** TWO methods that may be used locally to protect coastal communities from rising sea levels.

4. Dams are built by humans for various purposes including hydroelectric power generation and control of downstream flooding.
- (a) **Explain** how electricity is generated at a hydroelectric dam.
 - (b) **Identify** TWO economic benefits, other than hydroelectric power generation and control of downstream flooding, associated with dams.
 - (c) **Describe** one ecological benefit of seasonal flooding of the floodplain of a free-flowing river.
 - (d) Some dams have been removed from rivers.
 - (i) **Explain** how removal of a dam can benefit fish populations.
 - (ii) **Describe** one negative environmental consequence of removing a dam from a river (other than effects on fish populations).
 - (e) Dams are also built by beavers, a keystone species in some North American ecosystems.
 - (i) **Define** keystone species.
 - (ii) **Describe** how dams built by beavers can make beavers a keystone species in some ecosystems.

STOP

END OF EXAM

ENVIRONMENTAL SCIENCE**SECTION II****Time—90 minutes****4 Questions**

Directions: Answer all four questions, which are weighted equally; the suggested time is about 22 minutes for answering each question. Write all your answers on the pages following the questions in this book. Where calculations are required, clearly show how you arrived at your answer. Where explanation or discussion is required, support your answers with relevant information and/or specific examples.

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

Fremont New Tribune**May 2, 2016**

As another winter concludes, biologists are alarmed by the continued spread of white nose syndrome (WNS) in bats. WNS is a fungal disease that is decimating bat populations across eastern North American forests, with mortality rates reaching up to 100 percent at many sites. WNS has been found in at least 25 states in the United States and 5 Canadian provinces.

The fungus (*Pseudogymnoascus destructans*) grows well in cool conditions such as those found in caves and has been observed as white patches on the muzzles, noses, ears, and wings of many cave-dwelling bats. WNS has caused significant population declines for several bat species, including once-numerous species such as the little brown bat (*Myotis lucifugus*).

Little brown bats hunt using echolocation by emitting up to 200 high-frequency calls per second when pursuing their prey. When healthy, the little brown bat can live up to ten years and have one or two offspring (called pups) each year.

"Little brown bats provide tremendous value to the United States economy every year by the essential services they provide to farmers and other people. We need to understand how this deadly disease spreads and attempt to help reduce its impact on the little brown bat and other bat species," said Dr. Duke Serach of the Fremont office of the United States Fish and Wildlife Service. Dr. Serach concluded with, "It may yet be possible to save the little brown bats, but the remaining population will be alarmingly small."

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

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.