

CHAPTER 11 BIODIVERSITY: PRESERVING SPECIES

Chapter Overview

The concept of biodiversity is a fundamental topic of environmental science. Knowing that diversity can be described as either genetic, species or ecological should be understood by all AP students. The acronym HIPPO, standing for Habitat destruction, Invasive species, Pollution, Population [human], and Overharvesting is a good tool to introduce students to the major threats to biodiversity. These threats, along with climate change, must be in the repertoire of all AP students. Students should know that captive breeding programs and other survival plans are implemented to prevent species' extinction.

Topics and Key Concepts

The Living World

- Describe biodiversity with specific references to genetic, species and ecological diversity.
- Evaluate the benefits of biodiversity to humans, including ecological services as well as utilitarian and aesthetic values.

Population

- Evaluate the role of zoos, aquaria, and seed banks in the maintenance of biodiversity.

Land and Water Use

- Use the acronym HIPPO to explain the major threats to the world's biodiversity.
- Summarize the various United States laws and international treaties designed to maintain Earth's biodiversity.

Global Change

- Summarize case studies of various types of endangered species.
- Evaluate the success of the programs designed to avoid endangerment.
- Discuss captive breeding programs and the implementation of species recovery plans established by the USFWS and NMS.

Key Terms

biodiversity	flagship species	overharvesting
biodiversity hot spots	HIPPO	threatened species
endangered species	indicator species	umbrella species
existence (intrinsic) value	invasive species	vulnerable species
extinction	keystone species	

Pacing Guide

Biodiversity and habitat destruction make up approximately 10% of the AP outline. While everyone has heard of endangered species and the destruction of the tropical rainforest, can your students explain why an organism becomes endangered or why extinction is a natural process? Can they explain why the management of forests and other ecosystems is important to our survival? Allow 5 days to investigate and discuss this chapter. Students should begin to take note of the cyclical nature of the course at this point.

Approach and Tips

Taxonomy and classification form the basis of this chapter. Begin with the work that the early taxonomists, such as Linnaeus, did and continue the discussion using information based on the progression of scientific knowledge with new discoveries in genetics and DNA research.

Make sure students know the three components of biodiversity: genetic diversity, species diversity, and ecological diversity. Stress that genetic diversity describes the genes within a species, ecological diversity describes the number of niches, trophic levels, and ecological processes, and that species diversity describes the number of species in a community. With specific reference to species diversity explain the difference between richness and evenness. The total number of species in the community is its richness. The abundance of individuals within each species is its evenness. Emphasize the benefits that biodiversity provides to both natural ecosystems and to humans. These include food, drugs, aesthetics, and cultural benefits.

Biologist E.O. Wilson summarized the human threat to biodiversity using the acronym HIPPO (Habitat destruction, Invasive species, Pollution, Population [human], and Overharvesting). Many APES teachers have added a C for climate change, making the acronym HIPPCO. Emphasize the necessity to know each threat with examples. When discussing habitat alteration/destruction emphasize concepts from previous chapters. For instance, endemic is a term that the students should be familiar with and it is one that AP students should be able to explain in relation to the process of extinction.

Explain the nature of an invasive species. Ask them if they know of any invasive species in their area. Continue with a discussion on the invasive species in the area. Ask the students if they know where they came from and how they got there. Whether they were taken into an area for a specific purpose or were transported to an area unintentionally, the result is the same. Without population controls, these invaders displace the native species. Have students relate the characteristics of an invasive species to an *r*-strategist or a *k*-strategist species. Discuss which US states have the highest number of invasive species and explain why.

Discuss the harvesting of some commercial products in unsustainable ways. Have students make suggestions regarding what they can or will do differently to reduce their dependence upon unsustainable commerce. Ask them what organisms they purchase that are “human threatened species” and why these species are threatened by human activities. This discussion should segue nicely into a discussion about captive breeding programs as well as in situ protection for endangered and threatened organisms. Explain that captive breeding programs are an attempt to save threatened and endangered species. Describe successful captive breeding programs using specific species. When such programs are successful, endangered species can be reintroduced into the wild. Some organisms (use specific examples) do not breed in captivity, so endangered populations are maintained in captivity as a result of habitat destruction in their native habitat. Recall characteristics of organisms that may account for these differences.

By the 1890s, most states had enacted legislation to conserve resources and protect species, regardless of their usefulness to humans. Be sure that students know the distinction between an endangered species, threatened species and a vulnerable species. Endangered species are those considered most at risk for extinction. Threatened species are those that are likely to become endangered. Vulnerable species are those that are rare or have been depleted to a level that puts them at risk. Describe some recovery plans that are developed for species that are placed on the endangered or threatened list. Many regulations and laws have been established to protect species and habitats from human activity and resource depletion. Students should be familiar with the Endangered Species Act (ESA), the Lacey Act, Marine Mammal Protection Act, the NMSA, and CITES. While including these in your discussions, also refer students to future chapters, which give much more information on and insight into the actions of governments to protect the environment.

Common Mistakes and Misconceptions

Quite frequently, when students are asked to address the issues covered in this chapter, their answers are too vague. It is good to know that pollution is a problem, but that answer is not specific enough for an AP answer. The type of pollution must be specified. In addition, loss of biodiversity is a common answer that once again is classified as too vague. Biodiversity is considered a “buzz word” and will not receive credit unless there is a good explanation, including a specific anthropogenic cause, accompanying the phrase “loss of biodiversity”.

Activities

Endangered Species Zoo Project

Call a local zoo to get a list of endangered animals they have at the zoo. Assign each student a different animal to study, and have students complete the worksheet at the end of this chapter for their assigned species. Arrange a visit to the zoo for the class, and have students observe their animal for 15 minutes, recording what the animal is doing. Have the student take a digital picture of the zoo’s habitat for the animal. Students should then critique the animal’s zoo habitat using the information they obtained while researching the animal’s natural habitat. If a visit to a zoo is not possible, have students conduct their research online. Have the students include in their critique the vegetation, size and quality of containment, number of animals in the containment and the students personal reaction to the type of habitat it currently has. After the zoo, have the students get a piece of poster board and “design” a better habitat. Have the students use the research questions and the information they obtained while at the zoo to help them create their new habitat. Finally, have the students answer the following questions:

- a. What is the survival prospect of this animal?
- b. What is the value of a zoo for this animal?
- c. Is this animal able to breed in captivity, and has captive breeding been successful?
- d. What are the negative and positive aspects of the zoo for your animal?

Biodiversity Hotspots Activity

Begin with a discussion of the characteristics of a biodiversity hotspot. There are over 30 biodiversity hotspots in the world. Have each student investigate one hotspot and present their findings to the class in any format chosen. If you have a SmartBoard or a projector connected to a computer with internet access, you can bring up a website that shows the hotspots and play an interactive game with the class. Check to see if students know basic world geography. Then assign one

hotspot per student. As a follow-up to this activity, using a map of the world, have students (either the presenter or any student in the class) tack up a picture of one of their endangered species to the correct location. Make sure they have a correct species name on their picture. Have the students use the worksheet at the end of this chapter to guide their inquiry.

Fish Harvesting Methods Activity

Students should visit the website for the Monterey Bay Aquarium's Seafood Watch (<http://www.montereybayaquarium.org/conservation-and-science/our-programs/seafood-watch>) to complete a chart which includes a comparison of purse-seine, gill-netting, long-lining, trawls/dredges, and pots/traps. Students should be able to describe or illustrate the fishing technique and identify the type of unintentional fish (by-catch) caught. Once students can describe the methods of fishing, students should then describe alternative methods of fishing such as aquaculture. Students should include a description of each as well as the advantages and disadvantages of each method.

After the activity, students can view the video, "Empty Nets, Empty Oceans" at <http://www.pbs.org/emptyoceans/eoen/>.

Exotic Species Research

Students can create a brochure/research paper/presentation to provide education about an invasive exotic species. The paper should contain the following aspects:

- the organism's scientific name
- natural history information (habitat, breeding characteristics, food resources, niche, role in the ecosystem, etc.)
- location where the organism is indigenous
- method of introduction to a new habitat
- characteristics that make it a successful invasive
- characteristics of the new ecosystem that make it susceptible to invasion
- the invasive's impact on the new system
- strategies for eradication or further dispersal

Questions for Review

1. What are the three components of biodiversity?
Genetic diversity, species diversity, and ecological diversity.
2. How can HIPPO be used to explain species' extinction?

HIPPO is an acronym that translates to habitat destruction, invasive species, pollution, (human) population, and overharvesting. Each one of these can affect a species' population, particularly one that is endemic.

3. Why are specialist species more susceptible to extinction?

Specialist species have a very narrow set of conditions for survival. If their food source is found in only one area and that area is altered or destroyed, then the chances of their survival are slim.

4. What is an invasive species? Why are they considered a problem for indigenous species?

An invasive species is a species that is non-native and can reproduce and take over an area. They are a problem for indigenous species since they can out-compete the native species for resources, such as food/nutrients, leaving the native species to die out.

5. What are two major pieces of legislation that attempt to protect endangered species? What does each one regulate?

The Endangered Species Act is a U.S. law that regulates a wide range of activities involving endangered species, including "taking"(harassing, harming, pursuing, hunting, shooting, trapping, killing, capturing, or collecting) either accidentally or on purpose; importing into or exporting out of the United States; possessing, selling, transporting, or shipping; and selling or offering for sale any endangered species. CITES regulates worldwide the trade of living specimens and products derived from listed endangered species.

Practice Questions

Multiple Choice:

Directions for questions 1-5: The lettered choices below correspond to the descriptions given in questions 1-5. Select the one lettered choice that best fits each statement. Each choice may be used once, more than once, or not at all.

- (A) umbrella species
- (B) flagship species
- (C) keystone species
- (D) vulnerable species
- (E) threatened species

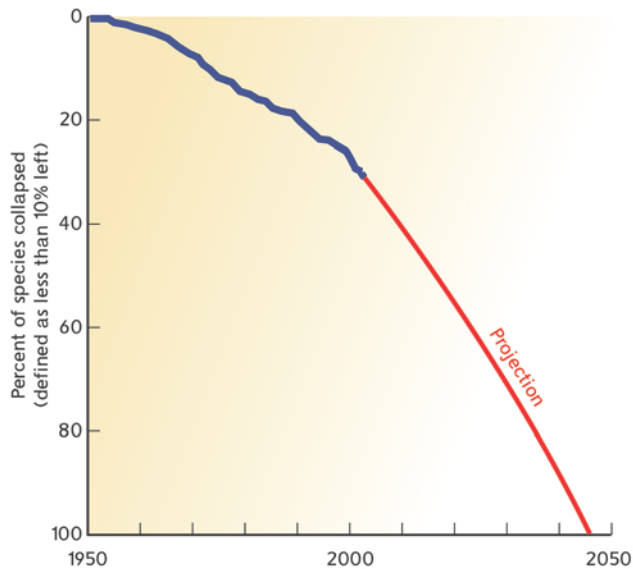
1. elimination of this species would affect many others in the community
2. attractive species to which people react to emotionally
3. a species that requires a large area in order to maintain a viable population
4. those species that are likely to become endangered
5. a naturally rare species
6. About one-third of all marine fish species are already in a state of population collapse. This is most likely due to _____.
 - (A) ecosystem revitalization
 - (B) pollution
 - (C) habitat destruction
 - (D) overharvesting
 - (E) population
7. All of the following have been used to describe invasive species except
 - (A) indigenous
 - (B) non-native
 - (C) alien
 - (D) exotic
 - (E) invaders

8. The most important extinction threat for most species is _____.
(A) ecosystem recovery
(B) population
(C) pollution
(D) overharvesting
(E) habitat loss
9. The use of private land to protect endangered species is called _____.
(A) resource recovery plan
(B) endangered species plan
(C) habitat conservation plan
(D) habitat protection plan
(E) new deal plan
10. Atrazine, a pesticide used on a fruit farm, has run-off into a local pond. The native species of fish in the pond has died. This species loss is a result of which part of HIPPO?
(A) Habitat loss
(B) Pollution
(C) Overharvesting
(D) Population
(E) All of the above

Free-Response Question:

Directions: Answer all parts of the following question. Where explanation or discussion is required, support your answers with relevant information and/or specific examples. When a calculation is required, be sure to show how you arrived at your answer.

1. The world's fisheries have been a provider of a major food source for people worldwide. However, the world's fisheries seem to be on an unsustainable course. Use the graph below to answer the following questions.



- (a) Explain the general trend of the graph.
 - (i) What is the main cause of this trend.
 - (ii) Give TWO reasons that account for a possible difference between the actual and projected value for the year 2000.
 - (iii) In what year is it projected that the fish stocks will completely collapse.
- (b) Describe TWO practices of fisheries that could lead to this decline.
- (c) Describe TWO practices that could be implemented to prevent the collapse of the seafood species.
- (d) Identify one major legislation that could be used to help reverse this trend.

Answers to Practice Questions

Multiple Choice:

1. C
2. B
3. A
4. E
5. D
6. D
7. A
8. E
9. C
10. B

Free-Response Question:

This question is based on 10 points.

1. (a) 1 point for indicating that the graph trend is decreasing or declining.
 - (i) 1 point for indicating that overharvesting is the cause of the decline
 - (ii) 2 points total. 1 point for each reason. Reasons can be: implementation of no-take zones, fish limits, fish size limits, natural protected areas.
 - (iii) 1 point for indicating the year. A range of 2043-2048 would be acceptable.
- (b) 2 points total. 1 point for each practice, possible practices include: taking all fish regardless of size, therefore the fish are not old enough to have reproduced, taking too many fish, no limits.
- (c) 2 points total. 1 point for each practice, possible practices include: size restrictions, catch limits, no-take zones established.
- (d) 1 point total. Since the students have not had any work on extensive laws and regulations, the only possible piece of legislation that applies would be the ESA. If one or more of the species taken are endangered, then they are protected by law.

Answers to questions in the Student Edition:

Case Study AP Document-Based Question (p. 227)

- (A) One environmental advantage of outlawing all use of a coral reef in an area is that without human interaction the reef can quickly recover. The recovery efforts can even extend to pelagic fisheries hundreds of miles away from the reef. One environmental disadvantage is that people that rely on reefs for food and a source of income will be upset by too strict of a plan that outlaws all use of the reef. The economies of some developing countries completely rely on coral reefs, so outlawing their use could completely devastate these countries and may still result in illegal, destructive fishing and tourist enterprises.
- (B) Anthropogenic threats to coral reefs include destructive fishing methods, coral mining, sediment runoff, pollution, irresponsible tourism, and contributions to climate change.

Use the Math (p. 229)

Answers will vary depending on how the student defines ‘mountains,’ but most of the regions can be argued to contain mountains. Nine regions are predominantly islands (Polynesia, Caribbean, Madagascar, Sundaland, Wallacea, Philippines, New Guinea, New Caledonia, and New Zealand). Approximately 12 are along coasts (depends on whether the student argues that the islands are also coasts). Answers will vary for the number of hot spots with two or more criteria, depending on the student’s justification. The greatest amounts of species are found in the tropical Andes, Mediterranean, and Sundaland. These are coastal mountains (Andes and Mediterranean), and mountainous islands (Sundaland), so it can be argued that hot spots with multiple criteria have more endemic species.

Use the Math (p. 230)

The greatest densities of endemic species is in Sundaland (medium-sized area with 15,000 species), Tropical Andes (medium sized-area with 20,000 species), and Madagascar (small area with 8,904 species). The lowest density of endemic species is Polynesia and Micronesia (very large area with 3,334 species). The different between the high and low density hot spots is that Polynesia and Micronesia have very small islands within their region, and the islands are very spread out. The high density areas are still isolated (islands or mountains), but closer to mainlands/other islands/mountains for a more consistent supply of new species to diversify.

AP Connections Review Answers (pages 247-248)

Multiple-Choice Questions

1. a. Endangered species tend to have large ranges or territories.
2. a

3. d. embryo transfer. Captive breeding, cross incubation, artificial insemination, and artificial incubation have all been used to increase the population size of the whooping crane.
4. c. White tail deer are not threatened or endangered, and immunocontraception is a method of birth control of wild animals that are overpopulating an area.

Data Analysis & Free-Response Questions

- 1a Three species have a positive trend (> 0): Roughed grouse, Wild turkey, and Virginia rail. A trend of 0 would mean no change in population size.
- 1b N is the the number of survey routes used in the calculations. A large N tends to *narrow* the confidence interval (the difference between lower and upper confidence limits) and gives scientists more certainty in the data they collect.
- 1c 54,705 Virginia Rails. This is calculated by increasing the prior population by 4.7% for each of 38 time steps: $t_0 = 10,000$ Virginia Rails, $t_1 = 10,470$...
- 2a R-selected species have short life spans, rapid growth, early maturity, have many offspring to which they provide little to no parental care, and are usually pioneers and colonizers in unstable environments. K-selected species have long life spans, slower growth, late maturity, have few offspring with high parental care, and are usually successional species in stable environments. Answers will vary.
- 2b Three key features to protect a large predator include adequate area, proper habitat, and a survival plan/programs to ensure healthy populations.

Biodiversity Hotspots Activity Worksheet

Student: _____

1. Where in the world is your hotspot? (geographic location)
2. In what biome is your hotspot located? Describe the basic climate patterns of your location.
3. List the plants and animals that are endemic.
4. Describe characteristics of at least two organisms that cause them to be endangered or threatened. Use your knowledge of *K*-selected species to address this.
5. Provide two human induced reasons for a decrease in biodiversity. What is being done to protect your hotspot?

Endangered Species Zoo Activity Worksheet

Student: _____

Research and answer the following questions about the endangered zoo animal that you have been assigned.

1. What does the animal eat?
2. How much food is required per day?
3. How does the animal obtain its food?
4. What adaptations does the animal have to survive?
5. What captivity problems has this animal encountered?
6. When does the animal eat?
7. What temperature range can this animal withstand?

8. What is the general vegetation of this animal's natural habitat?
9. At what height and depth in the habitat is this animal found?
10. What other animals would share this habitat?
11. In what trophic level of the food chain would this animal be found?
12. Why is this animal on the endangered species list?
13. What steps are being taken to help this animal survive?
14. Why is it important to protect this animal?