CHAPTER 13 RESTORATION ECOLOGY

Chapter Overview

Restoration is an important AP topic. The idea of resilience reinforces the concept of secondary succession. Understanding the role of fire in maintaining natural ecosystems and the connections to the cycling of nutrients are essential concepts. The restoration of vital ecosystems maintains biodiversity.

Topics and Key Concepts

Land and Water Use

- Summarize the history of restoration in the United States.
- Explain the five steps needed for restoration of an ecosystem.
- Differentiate restoration, reclamation, recreation, rehabilitation, and remediation.
- Summarize the methods used to restore prairies.
- Explain the role of fire in maintaining ecosystems and list specific examples of fire-based maintenance.
- Discuss the history of reclaiming wetlands and streams.

Pollution

- Summarize the damage to and restoration of the Everglades.

Key Terms

bioremediation
buffalo commons
ecological restoration
intervention
mitigation
novel ecosystem
oak savanna
prairie potholes
prescribed burning
reallocation
reclamation
re-creation
rehabilitation
remediation
restoration
wetland mitigation

Pacing Guide

The AP topic outline suggests 5-10 percent of the course include habitat loss, overuse, pollution, introduced species, maintenance through conservation, management of wilderness areas, national parks, wildlife refuges, forests, and wetlands. Plan to spend 3-4 days to cover the material presented in this chapter.

Approach and Tips

Begin by having the students describe what the habitat they live in was like 20, 50, and 100 years ago. Some research may be needed to determine what changes have taken place; others may not have experienced as much change, depending upon their location. Discuss the role of ecosystem management in preserving habitat and how developers in your area succeeded or failed depending upon the student's viewpoint.

Stress the importance of the terminology covered in the Restoration Glossary

A Restoration Glossary
Some commonly used terms in restoration ecology:
• **Restoration** (strict sense) to return a biological community to its predisturbance structure and function.
• **Restoration** (broad sense) to reverse degradation and reestablish some aspects of an ecosystem that previously existed on a site.
• **Rehabilitation** to rebuild a community to a useful, functioning state but not necessarily its original condition.
• **Intervention** to apply techniques to discourage or reduce undesired organisms and favor or promote desired species.
• **Reallocation** to use a site (and its resources) to create a new and different kind of biological community rather than the existing one.
• **Remediation** to clean chemical contaminants from a polluted area using relatively mild or nondestructive methods.
• **Reclamation** to use powerful chemical or physical methods to clean and repair severely degraded or even barren sites.
• **Re-creation** to construct an entirely new ecosystem on a severely degraded site.
• **Mitigation** to replace a degraded site with one of more or less equal ecological value somewhere else.

You may want to assign specific national parks or refuges for students to research, or have them research the roles of the U.S. Forest Service or National Park Service to determine what students may view as the conflicts of interest that occur with multiple use contracts (for example, logging in national forests).

Using Hurricane Katrina, Mount St. Helens, or Prince William Sound as an example, illustrate how humans have helped ecosystems heal. Re-visit the concept of resilience and explain how an ecosystem when left alone will undergo succession to a climax community. Using the same example, run through the five steps necessary for ecosystem restoration. Emphasize the need for each step and that different ecosystems may need different techniques, but the basics will be the same. Stress the five steps: removing the cause of the disturbance, controlling invasive species, replanting with native vegetation, captive breeding

and reintroduction of native fauna, and careful ongoing monitoring—"before, during and after" so that progress can be analyzed and additional steps taken if needed.

Use the University of Wisconsin's Curtis Prairie as an example of prairie restoration. Emphasize the importance of the grasses to this ecosystem. Also stress the importance of animals to the prairie, in particular, the bison. Make sure the students understand the role of fire in prairie restoration and the role of fire in any of the fire-based ecosystems, including southern pine forest, chaparrals, and coastal redwood forests. Address the nitrogen and carbon cycles when discussing the role of fire. The connections to the nutrient cycles are very important.

The portions of the chapter that deal with remediation and the importance of wetlands should be given additional emphasis at some point during the course. You may choose to include this discussion when you cover water pollution and the students have more background information to refer to. Explain the different restoration plans for various wetlands. The restoration of the Everglades in Florida is a project that all AP students should know. Emphasize the role of mitigation when considering wetland restoration. Bioremediation is a fundamental concept. Using examples, such as the use of bacteria to break down oil on a beach, make sure the students understand the nature of this topic. Have the students research this topic and come to class with other specific examples.

Have students design an experiment examining habitat fragmentation or reduction. Commonly used organisms include land snails, crickets, mealworms, and *Daphnia*.

Common Mistakes and Misconceptions

Students often fail to make the connections between concepts such as restoration, resilience and nutrient cycling. These are interconnected concepts that are fundamental topics for the AP course.

Activities

Ecotourism Brochure Activity

This activity is to assist students in learning ways that we can help nature heal and to show that restoring ecosystems has benefits.

Assign each group of two to four students an area that needs restoration.

- Ex. Forests (Costa Rica, National Parks, Japan after WWII, etc.), prairies (Great Plains), wetlands and streams (Everglades, Chesapeake Bay), Great Barrier Reef.

Have each group design a tri-fold ecotourism travel brochure. The idea is to include information on how their company is restoring this ecosystem and why tourists would want to visit and hire this company to take them on the trip. The information to be included in the brochure can be found in the worksheet at the end of this teacher's manual chapter.

Restoration Activity

This activity deals with a current event, the Deepwater Horizon Oil Rig explosion and subsequent oil spill. Begin with a discussion of the oil spill and the resulting environmental damage. Show pictures of the environment before and after the oil spill. Have students research the effects of the oil spill, damage control of the oil spill, remediation, and restoration of the fragile gulf ecosystems. A worksheet for this activity can be found at the end of this teacher's manual chapter.

Questions for Review

1. What are the four aspects of restoration ecology? What human activities could have caused the disturbances in each aspect?
   The four aspects are rehabilitation, remediation, reclamation, and re-creation. Rehabilitation could help to restore a site that may have been subjected to an oil spill. Remediation could help to remove toxic metals from a marsh by using plants that uptake these metals. Reclamation could help to heal the land after strip mining for coal. Re-creation might help to mitigate the effects of water withdrawal, possibly for agriculture, from a wetland.

2. Why is maintaining biological diversity a key component of ecosystem management?
   High levels of biodiversity indicate healthy ecosystems. The more biodiversity an ecosystem has, the more resilient and adaptable an ecosystem is to change. It improves ecosystem functioning. On the other hand, low levels of biodiversity make ecosystems vulnerable and reduce their ability to recover from a stress.

3. Why is fire suppression a controversial practice?
   Fires help to maintain ecosystem integrity and renewal. Fires naturally reinvigorate ecosystems by replenishing nutrients into the soil. In addition, some species of plants need fire in order to carry out their reproductive strategy. Suppressing fires builds up fuel load and then when a fire does break out, the fire is more intense and destructive.

4. Why is wetland restoration a challenging project?
   The very nature of a wetland presents a challenge when restoring. Wetlands involve both terrestrial and aquatic habitats that are tightly coupled. They have high levels of biodiversity, and unique physical, chemical, and physical properties.

5. In what way is the American bison a keystone species?
   The American bisons' trampling and intense grazing disturb the ground and provide an opening for pioneer species. The buffalo chips they leave behind fertilize the soil and help the successional process thereby maintaining the prairie ecosystem.

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) John Muir
(B) Aldo Leopold
(C) Rachel Carson
(D) Gifford Pinchot
(E) John F. Kennedy

1. author of "Silent Spring" that presented the dangers of pesticide use

2. author of "Sand County Almanac"

3. founder of the Sierra Club

4. his/her Land Ethic philosophy reflects the existence of an ecological conscience

5. first head of the U. S. Forest Service

6. Compensation for destroying a site is called _____.
   (A) mitigation
   (B) restoration
   (C) rehabilitation
   (D) remediation
   (E) re-creation

7. In the early 1900s logging companies devastated regions without any reclamation or replanting. This was called _____.
   (A) here and there
   (B) logging production rights
   (C) cut and run
   (D) cut and cut more
   (E) select cut

8. Native areas frequently regenerate themselves through the process of _____.
   (A) natural selection
   (B) secondary production
   (C) succession
   (D) primary production
   (E) rejuvenation

9. Which of the following is NOT a step in ecological restoration?
   (A) Picking up litter
   (B) Removing invasive species
   (C) Replanting native species
   (D) Clean up of a local river
   (E) Planting exotic species

10. One of the most expensive restoration projects is _____.
   (A) the University of Wisconsin's Curtis Prairie
   (B) the damming of the Mississippi River
   (C) the Okefenoke Swamp
   (D) the Everglades
   (E) the Great Lakes Forest

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 Knightland logging company has clear cut an area in a national forest. Answer the following questions pertaining to restoration and ecosystem management.

   (a) Describe **two** environmental problems that result from the clear cutting of the forest.

   (b) Describe **two** sustainable logging practices that might lead to restoration.

   (c) Identify **three** ecosystem services obtained from the forest.

   (d) What is the role of the forest in the carbon cycle?

   (e) Explain **two** economic benefits from the logging company's operation.

Answers to Practice Questions

Multiple Choice:

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

Free-Response Question:

This question is based on 10 points.

1. (a) 2 points total. 1 point for each description. Descriptions of the following terms would be acceptable: soil erosion, habitat loss, loss of biodiversity

   (b) 2 points total. 1 point for each description. Descriptions of the following terms would be acceptable: replanting, selective cutting (harvesting)

   (c) 3 points total. 1 point for each ecosystem service. Ecosystem services include, but not limited to: camping, hunting, timber for housing, wood for paper production, bird watching, carbon sink

   (d) 1 point for correctly indicating that the forest is a carbon sink.

   (e) 2 points total. One point for each economic benefit. Benefits include: jobs, boost to the local economy, lumber company increases profits

Answers to questions in the Student Edition:

Case Study AP Document-Based Question (p. 276)

(A) The Elwha River restoration was a long-term, but successful project. Basically, two dams were built amidst protest that eliminated spawning grounds for migratory salmon and steelhead trout, and damaged the livelihood of indigenous populations. Furthermore, the dams disrupted the river ecosystem by decreasing nutrients and sediments transported downriver. Then when the dams were up for relicensing, many groups opposed it, saying that the dams were detrimental and illegal,

eventually leading to funds being appropriated to remove the dams. Two decades passed before the dams were ultimately taken down in what is the largest dam removal in the US. Special care had to be taken to control sediment and aid restoration, and monitoring is still taking place to make sure the animal numbers (including salmon) are going back up in the newly restored rivers and forests. Two challenges that this and other restoration projects face is the scale of the project, the funds for the project, and the time required to do the job correctly.

(B) The Elwha River restoration project is unique in that it is in a national park and a protected area. Unfortunately, not all damaged rivers that need restoration are in protected areas so their restoration efforts are not as successful as the Elwha River.

AP Connections Review Answers (pages 298-299)

Multiple-Choice Questions

1. b. The algae have 10,000 kcal of energy. By assuming that 10 percent of the energy is available to subsequent trophic levels, the zooplankton have 1,000 kcal available and the minnow would have 100 kcal available.

2. b. Simple sugars, carbohydrates, and lipids contain the elements C, H, and O. In addition to those three elements, proteins also contain N. DNA is the only choice that has P as part of its structure.

3. a. Neither cellular respiration nor photosynthesis produces hydrogen, nitrogen, or methane gas. None of those gases were mentioned as a part of the life-sustaining energy conversions found in photosynthesis and respiration. The choices are between carbon dioxide and oxygen gas. Respiration uses oxygen and produces carbon dioxide as a by-product.

4. e. Water has a high heat of vaporization, expands as it freezes, and is polar. Cohesion is the tendency for water to stick to itself.

5. e, 1000. The pH scale is logarithmic; each step down in pH indicates a solution that is 10 times more acidic.

6. c. All other choices are examples of potential energy.

7. c. The hyenas are scavengers.

8. b, community.

Data Analysis & Free-Response Questions

1a The usual limiting factors for growth of phytoplankton in an aquatic ecosystem include nitrogen and phosphorus. When either increase (usually from man-made sources), populations can explode resulting in eutrophication.

1b A simplified food web for a coastal ecosystem can be created by modifying the terrestrial example in Figure 3.14. It should include these categories and may include some of the following examples:

Primary Producers (autotrophs): phytoplankton, algae, seagrass
Primary Consumers (herbivores): zooplankton, sea turtles, fish
Secondary Consumers (carnivores): fish, birds
Tertiary Consumers (top carnivores): sharks, alligators

The phytoplankton's normal role is as a primary producer, or autotroph.

1c The first law of thermodynamics states that energy is conserved (neither created nor destroyed). In energy transfer in a food web, the energy available in a consumed organism is taken by the consuming organism. The second law of thermodynamics states that with each successive transfer, less energy is available to do work (energy is degraded to lower-quality forms). Energy is used by each organism for maintenance – each time a cell does work, it takes energy, resulting in less energy available for higher trophic levels. Some of this energy is also "lost" in the form of heat.

2a The largest dead zone was approximately 22,000 square kilometers in size, and the smallest dead zone was approximately 4,000 square kilometers in size. [(22,000 – 4,000)/4,000]*100 = 450% increase.

2b The highest moving average is for the year 2007.

Ecotourism Brochure Activity Worksheet

*Student:*_____

1. Why is this environment important?

2. What is being done to restore this habitat?

3. Are noninvasive species a problem and, if so, how are these being addressed?

4. What percentage of the natural environment is left?

5. What caused the destruction of this habitat in the first place?

6. Include a map of the area.

7. List some native species that inhabit this environment. Are any of these endemic?

8. What are some things that the travelers can do to help?

9. What are the unique characteristics of this area?

10. From an environmental perspective, why should we care what happens to this environment?

11. Be sure to include your company's name, phone number, price of the trip, and what all is included.

Restoration Activity Worksheet

*Student:*_____

1. Is the Gulf ecosystem restoration being done in the strict sense or the broad sense? Explain.

2. Describe any rehabilitation planned? Are there economic costs to the ecosystems? Name two economic costs and two environmental costs.

3. Is any intervention planned? Explain.

4. How can the concept of reallocation be applied in this circumstance?

5. What remediation techniques were used to remove the oil?

6. Describe any attempts for reclamation.