Unit 9

Biodiversity Decline

Background

Introduction

In 1854, Chief Seattle said, "Man did not weave the web of life—he is merely a strand in it. Whatever he does to the web, he does to himself." Extinctions are occurring at an alarming rate due to human behavior. As humans expand their habitat and introduce invasive species, more native species are put at risk. Biodiversity is important for the stability of ecosystems. When one species is removed from an ecosystem, it is hard to predict what impact it will have on the rest of the organisms in the ecosystem. It is a difficult task, but scientists need to define and measure biodiversity to determine exactly what it is that we are at risk of losing. It is critical that we discuss how to protect biodiversity while we are still defining it.

Essential Questions

How is the health and stability of our ecosystem related to biodiversity?

What impact will biodiversity loss have on humans and other life?

How can we protect biodiversity?

Content

Unit 9 focuses on the importance of biodiversity to the health of ecosystems. Part One of the video is with Dr. Bill Laurance and Dr. Sue Laurance from the Smithsonian Tropical Research Institute. Their main focus is to determine how humans affect the tropical rainforest. We are losing 80 football fields of tropical rainforest per minute, ultimately leading to the extinction of thousands of species, many of which we've never even identified.

Part Two follows Professor Jeremy Jackson and his research studies of ocean ecology. His primary focus is on human impact on ocean ecosystems. He discusses how the shifting baseline syndrome makes it hard to know the entire impact over-fishing has had on the ecosystem. He has found that 90 percent of the big fish are gone compared with data from the 1950s. When the large fish are gone, seaweed overgrows and destroys the coral, demonstrating that removing just one species can lead to the collapse of an entire ecosystem.

Background

Learning Goals

During this session you will have an opportunity to build understandings of the following.

a. Knowledge
   i. Biodiversity encompasses genetic, species, and ecosystem diversity.
   ii. Fossil records help scientists understand biodiversity.
   iii. Threatened, endangered, and extinct species are indicators of general ecosystem health.
   iv. Humans are the cause of the sixth mass extinction.
   v. Biodiversity is threatened in many ways.
   vi. Habitat loss and invasive exotic species are the largest cause of biodiversity loss worldwide.
   vii. Pollution and over-harvesting threaten biodiversity.

b. Skills
   i. Science is a descriptive process.
   ii. Science is an experimental process.
   iii. Science helps explain current events.

c. Dispositions
   i. Communicate reasons why biodiversity is valuable and should be preserved.
   ii. Identify actions one can take to help preserve biodiversity.

Key Concepts

Biodiversity	Ecosystem
Carrying capacity	Species
Species richness	Genetic diversity
Gene pool	Natural selection
Threatened species	Endangered species
Vulnerable species	Extinct
Habitat	Generalist
Specialist	Habitat fragmentation
Exotic species	Invasive species
Baseline	Endangered species act (ESA)

FACILITATOR: These concepts correspond roughly to the sections of the unit. There are a number of other concepts that could be included. It is best to start with the author's major ideas and then ask for input from the study group for other concepts they would include.

Background

Misconceptions about Biodiversity

Below are some misconceptions that people may have about biodiversity, as well as some clarifying information.

Not all species are important, so some have to be sacrificed.

Often it is difficult to fully appreciate the complete impact a species has on an ecosystem. The complex interactions between species are often unknown. The loss of a single pollinator could have profound effects seen all the way up through the food chain.

If there is a lot of one species, then the ecosystem must be healthy. For example, if there are a lot of rock doves (pigeons) in the park, then the ecosystem is healthy.

In fact, to have a healthy ecosystem you need diversity with populations that approach the carrying capacity of an ecosystem.

It is very common for people to think that large empty spaces that are unmanaged are wastelands. This can range from a vast expanse of desert to an abandoned city lot.

However, we know that ecologically these spaces are very necessary to provide habitat for many species, thus protecting our biodiversity.

Biodiversity is not important to humans.

It is a common misconception that humans are not part of the ecosystem, but we indeed are an important part in the web of life and so biodiversity is important for us.

Getting Ready (45 minutes)

Activity One: Assessing Prior Knowledge, Questions, and Related Experiences

FACILITATOR: Distribute index cards to the study group. On the first card, participants should indicate something they know about biodiversity. On the second, they should write one question they have about biodiversity. And on the third card, they should describe a direct experience that they have had that relates to biodiversity. For example an individual might write:

There are two different types of squirrels that live in the park.

How many types of plants and animals live in my community?

I took a beautiful walk in the forest when I visited Mexico.

Getting Ready

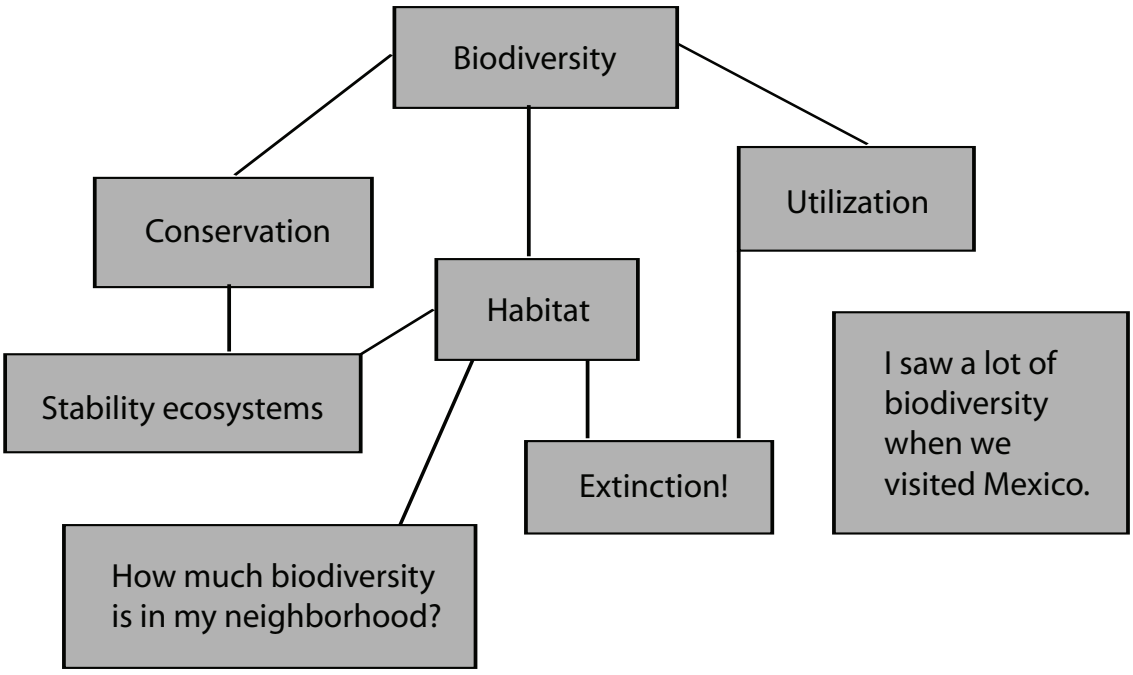

Figure 9.1 An example of a study groups' idea collection, with major subjects identified and the addition of the major focus ideas of the video. This activity links individual pre-existing knowledge with that of other members of the group and the unit content.

Activity Two: Current Events & Editorial Cartoons

Participants will share an article that they have found related to the week's topic. Everyone in the group will share their headlines for the articles. The leader should ask a few people to summarize their articles and ask for comments from others with related articles. As the group discusses the articles, a participant should record key concepts and make a list. (Participants may choose to bring in a cartoon or an editorial related to the week's topic instead of an article.)

Activity Three: Biodiversity Pre-Test

Another approach to testing prior knowledge is to conduct a pre-test. Participants should take the test below anonymously and then choose one of the following options.

1. The facilitator will analyze the results for misconceptions and discuss the results at the next meeting.
2. The facilitator leads a large group discussion of the correct answers directly after participants take the test.
3. Participants get in small groups and discuss their answers.

At the end of this unit, participants should take the test again to see what they have learned.

Getting Ready

Test Yourself: How Much Do You Know About Biodiversity?

Mark T in front of each statement you believe is true and mark F in front of each statement you believe is false. *Answers to the test below can be found after the Between Sessions section.*

_____ 1. All species on Earth have already been discovered.

_____ 2. More than one half of the world's species live in tropical forests.

_____ 3. Just over 10 million species have been identified by scientists.

_____ 4. Earth has more species than it needs.

_____ 5. Most species do not benefit humans.

_____ 6. All habitats have the same number of species.

_____ 7. Biodiversity includes genetic diversity, species diversity, and ecosystem diversity.

_____ 8. Biological diversity is more threatened now than at any time in the past 65 million years.

_____ 9. The loss of forests, wetlands, grasslands, and other habitats contributes to loss of biodiversity.

_____10. Many species become extinct without ever being identified.

_____11. Large plants, birds, and mammals make up half the world's species.

_____ 12. The countries with the most species of plants are located in Central and South America and in Southeast Asia.

_____13. Coral reefs are as rich in biodiversity as tropical forests.

_____14. Islands can be homes to species found nowhere else.

_____15. Fewer than 100 species currently provide most of the world's food supply.

_____16. Crop breeders need a diversity of crop varieties in order to breed new varieties that resist insect pests and diseases.

_____17. Creating parks and zoos is the best way to preserve biodiversity.

_____18. The biological resources of developing countries are a possible source of income.

_____19. Two major causes of biodiversity loss are population growth and the increasing consumption of natural resources.

_____20. Once a species becomes endangered, it will become extinct.

Video (45 minutes)

Activity Four: Watch the Video

As you watch the video, think about the following focus questions.

1. What is Dr. Bill Laurance studying? How does it relate to biodiversity?
2. What is forest fragmentation? Why are scientists concerned about forest fragmentation?
3. Why are tropical rainforests described as the lungs of the planet?
4. How are old-growth trees and birds affected by the increase of the forest edge, according to Dr. Sue Laurance?
5. What is Professor Jeremy Jackson studying? How does it relate to biodiversity?
6. What is the importance of coral reefs to the ecosystem.
7. Why is a baseline so important? Why can't you just look at how the world is now?

Activity Five: Discuss the Video

Discuss the following questions about the video and how it applies to your situation?

1. Describe the research being conducted in the tropical rainforest and in the coral reefs. Compare and contrast these investigations.
2. Will the land fragmentation lead to "islands of survival" or "islands of extinction"?
3. How have people changed the ocean ecosystem?
4. Construct a food web of the ocean ecosystem. What happens to this web when fish are removed? How does it relate to the loss of biodiversity?
5. Discuss the "Rise of Slime."
6. What can you do to address the problem of biodiversity loss?

FACILITATOR: Refer back to the misconception section and Activity One: Assessing Prior Knowledge. Has the video contributed to the participants' new understanding of concepts? Are there any changes the participants would make about the arrangement of their cards from Activity One?

Going Further (60 minutes)

Activity Six: Timber Harvesting Community Role Play

This is a group activity where participants will read a case study, role play, and, as a group, come to a consensus on how the issue can be resolved. The activity requires a minimum of 8 participants.

1. Before class, prepare the role cards. Participants are going to be in groups of eight. Determine how many groups of eight you will have and then number the cards accordingly. For example, if you have 24 participants, you will have three groups, so you should make three copies of the set of roles. Place a 1 on each role card in the first set, place a 2 on each role card in the second set, place a 3 on each role card in the third set, etc.

Going Further

2. Participants should read the case study.
3. The roles are as follows: facilitators, local citizens, land managers, conservation biologists, recreational housing developers, county commissioners, timber company representative, and land trust representatives.
4. Split the participants into 8 groups and assign a role to each group.
5. Give each group a copy of their role card. People in this group all have the same role. Give participants approximately 5 minutes to discuss their interests in the cases, possible actions, etc.
6. Have participants get in their new groups according to the number on their role card. In each group there should be one of each role. If you don't have a multiple of 8 then one participant may have to take on two roles. Each group must have a facilitator.
7. When participants are in their groups, the facilitator should have each member express his or her concerns. After everyone has had a chance to speak, then the group needs to come to a consensus. The facilitator should take notes, record the group's consensus, and have everyone sign the paper before it is turned in.
8. When every group has come to a consensus, the group facilitator should then share the results with the rest of the group.
9. After each group has made its presentation, discuss how biodiversity was at risk in this case study.
10. Just as we saw in the video, land fragmentation is an issue here as well. Discuss how and why this is a problem. Has anything like this happened in your community?

Case Study

A publicly traded timber company is feeling pressure to improve its bottom line. Due to increased international competition and a spike in the price of raw materials due to local over-harvesting, profits have plummeted and shareholders are demanding a turnaround. To make a quick profit, the company has decided to sell 250,000 acres of forested land to the highest bidder. Approximately one fourth of the land they intend to sell has river and lake frontage and thus will be sold at a premium. Because these particular tracts are more valuable, these parcels are sub-divided into the smallest plots zoning allows in order to maximize profit. The smallest lakeshore lot size the local government will allow is five acres. Other parcels will be divided into 10-, 20-, and 40-acre lots so they can be sold as quickly as possible.

Local government officials are in favor of this action because it will increase the local tax base, allowing residents' taxes to go down or remain stable while increasing the services (e.g., new or improved highways, social services, etc.) provided to the community.

However, these forested lands are unique, providing critical habitat to many species, particularly migratory songbirds that spend the summer here. Of the 56 species that time their migration to coincide with the abundance of insects to feed their young, 12 are threatened and 2 are on the brink of extinction. Because of the unique bird species found here, a national birding organization has named the area one of the five top "hot spots" for members to add to their species life lists. An activity not to be overlooked, bird-watching has become the most popular outdoor recreational activity and local motel owners have recently noticed an increase in the number of birders. To capitalize on this opportunity, the hospitality industry, the state tourism board, and birding organizations are proposing a birdwatchers' auto route through the area.

As the timber company places its land on the market, a local developer takes notice and proposes to buy the prime lake and riverfront properties in order to develop recreational housing on them. The developer's proposal calls for cabins and summer homes to be built on one acre lots. Since this plan would exceed the current zoning standard, the developer must ask for an exemption from the county planning and zoning office. A national land trust, recognizing the importance of this land for wildlife, has also begun negotiating with the timber company. Its goal is to preserve land for future generations, but it would be unable to do so if the county planning and zoning office approves the decreased lot size.

What should this community do?

Going Further

Case Study Role Cards

Local Citizen
You are concerned about how your family's quality of life will be changed by this development. Hunting and fishing have a long history in the area and are an annual tradition. These opportunities will be reduced as more land will be posted "Closed." With more houses and roads there will be an increase in storm water run-off, and water quality will decrease, affecting fishing in the remaining lakes and rivers. Competition for use of the remaining public lands will increase.

Conservation Biologist
Your job is to do research. You have studied the forest ecosystem that is being considered for development. You know that these woodlands are an important habitat for nesting songbirds that are threatened and endangered. In other areas you have seen their population decline dramatically after development. You also know that these birds are an indicator species; a decrease in their population tells you that the entire ecosystem is being affected.

County Commissioner
Your job is to oversee the functioning of the county government and pass resolutions affecting land use. You were elected by the people to represent their best interests. You would like to see development because it will increase the local tax base and that will mean a decrease, or a least no increase, in taxes from your constituents. Also, this development will increase employment opportunities. With a new election coming soon, you want to please your constituents.

Recreational Housing Developer
People need recreational homes to get away from the city and "revive" themselves. The local economy also needs this development, which will provide much needed employment opportunities.

Land Manager
Your job is to enforce how land is managed and cared for. You are an advisor to the county commissioner and you would like to see development minimized, especially around water. You will recommend that any housing developments are set back at least 200 feet from any body of water in order to decrease the rate of surface water run-off and the amount of nutrient loading. Too many nutrients in the water will decrease the habitat for fish and other aquatic species.

Timber Company Representative
You want to make as much money from the 250,000 acres as possible but are still willing to listen to the concerns from the community.

Facilitator
Your job is to make sure everyone at the table has a chance to speak and that they are heard. You should not share your personal opinions. You need to help the group come to a consensus on a plan. You should take notes and record the resolution that the group agrees upon. Once the group has agreed to the resolution, you should have each sign the document while also recording the role he or she played.

Land Trust Representative
Your organization would like to purchase this land to ensure that it remains undeveloped. You are very concerned about the loss of ecosystem diversity. However, your group cannot afford the same price as the housing developer. As a non-profit organization, your group does not have to pay property taxes. However, you are willing to pay the taxes in order to help maintain the tax base of the community.

Going Further

Activity Seven: Return to Essential Questions

The facilitator should draw the attention of the participants back to the essential questions posed in the Background Section of this unit guide. Discuss how the participants' ideas may have changed in regard to the questions. Discuss the most logical and complete answers to the questions.

Activity Eight: Discuss Classroom Supplementary Activities

Following the Between Sessions section of each unit are Classroom Supplementary Activities. These activities are related to the unit topic and are suitable for middle and secondary science classrooms. If the participants in this study group are teachers, the facilitator should take the time to review these lessons. If participants are familiar with the lessons, they should describe how they have used them. Discuss how the classroom activities might be used in relation to a specific science topic and how the activities can help relate the unit topic to classroom lessons.

Between Sessions

Next Week's Topic Overview

Read Unit 10 before the next session. In Unit 10, the emphasis is on energy—the types of energy we use and the impact it has on the environment. From industrial to household consumption of electricity and transportation, we are all dependent on energy. This unit discusses the environmental impact that results from of our use of non-renewable forms of energy and the types of renewable forms of energy that exist.

Read for Next Session

For the next session, be sure to read the Unit 10 Professional Development Guide background section. Consider the essential questions as you read the text. The misconceptions section will give you some insight into what misunderstandings people may have about energy. Consider discussing the topic with your friends or students and discussing common misconceptions.

Between Sessions

Current Events

Bring in a current event article or cartoon related to energy.

Answers to "How Much Do You Know About Biodiversity?"

1. *False.* Scientists discover new species daily and they estimate that there may be as many as 30 million species.
2. *True.* Over one half of the world's species live in tropical forests.
3. *False.* It is estimated that fewer than 1.4 million of the world's species have been named. Most of the unidentified species live in the tropics and in the ocean.
4. *False.* Species evolve to fill particular niches or habitats that exist on Earth. Many species depend on each other for survival. Destroying one species can lead to further extinction or changes.
5. *True or False.* We don't know. Scientists are often delighted to find a cure for a human disease in a mold or obscure plant. It seems foolish to destroy our genetic storehouse before we have even taken inventory. Also, extinction of a species can upset the balance of a complex ecosystem.
6. *False.* Some habitats, such as tropical forests, have many more species than others.
7. *True.* Biodiversity includes genetic, species, and ecosystem diversity.
8. True. Tropical deforestation is the main force behind this crisis. The destruction of wetlands, coral reefs, and temperate forests is also important.
9. *True.* As habitats are fragmented and destroyed, many species become extinct.
10. *True.* Habitats are destroyed without being studied.
11. *False.* Large, visible species of mammals, birds, and plants make up fewer than 5 percent of the world's species.
12. *True.* The world's rainforests are located in these countries.
13. *True.* Coral reefs are habitats with biotic richness.
14. *True.* Remote islands such as Hawaii have unique flora because evolution takes place there in isolation.
15. *True.* Fewer species are grown today than in the past. Genetic diversity is declining.
16. *True.* Monocultures dominate most forms of agriculture.
17. *False.* Zoos and parks are traditional strategies for protecting biodiversity and have helped preserve many species. However, newer strategies are needed to address the root causes of biodiversity loss.
18. *True.* The biologic beauty of these countries is an economic benefit as tourism increases.
19. *True.* Other root causes are lack of knowledge of species and ecosystems, poorly conceived policies (for example, those that favor deforestation), and the failure of economic systems to account for the value of biological resources.
20. *False.* Species can be protected by preserving habitat and by breeding programs in zoos and botanic gardens.

Supplementary Classroom Activity 1

BioBlitz

The BioBlitz is a chance for schools and communities to explore the biodiversity in their own backyards. By doing a BioBlitz you are able to determine what is living in a particular area at a particular point in time. To complete this activity you want to involve as many people as you can. The challenge is to document as many species as possible in a 24 hour period. The event can be as scientific as you want to make it and you can bring in professionals in your area to help you document as many species and taxonomic groups as possible. A BioBlitz gets people involved in their own communities and promotes a positive awareness of resources and local conservation. This is also a great opportunity for students and adults to experience first-hand how real science is put to work.

Prior to completing the BioBlitz you will want to select a site and collect several sets of field guides of all species (e.g., birds, fungi, lichens, mammals, plants, trees, insects, aquatic invertebrates). A kit should be made for each group of participants. These kits can be made with large plastic bags and should include: field guides, a first aid kit, map, binoculars, hand lens, snacks, and a data sheet.

Sample Data Sheet

Scientific Name	Common Name	Taxonomic Type	Site Found

If this becomes an annual activity, participants in the BioBlitz can discuss whether the biodiversity is changing and if so, why? This would also provide an opportunity to discuss the necessity of a baseline as was discussed in the video for this unit.

The following web links may be useful:

http://web.uconn.edu/mnh/bioblitz/

http://www.fieldmuseum.org/bioblitz/

http://www.pwrc.usgs.gov/blitz/

Supplementary Classroom Activity 2

Exotic Species

The introduction of exotic or invasive species is one of the main causes of loss of biodiversity. Students are split into groups of three. Each group researches one exotic or non-native species in its area to find out how it got there, what native species it is displacing, and what actions can be taken to prevent further spreading of this species. Each group should then share its findings with the rest of the class by creating an informational poster. The poster should include the following information:

- Picture
- Where the species is found
- Where it came from
- Whether it was introduced accidentally or deliberately
- What harm it does to the environment or economy
- What native species have been displaced
- What can be done to prevent further spreading

Removal of invasive plant species, such as spotted knapweed: After consulting local government and receiving permission and instructions, students could remove the invasive plant species in their area while keeping population data and location using a GPS.