Activity 1: Before and After

Based on video content

15 minutes (10 minutes before and 5 minutes after the video)

Setup

We all appreciate both the beauty and the biological importance of areas with natural diversity. This unit explores the current techniques for measuring, investigating, and making hypotheses about this diversity. The issues go far beyond aesthetics and basic biology, and have an impact on human health, recovery of land after natural disasters, and the preservation of life on earth.

Before viewing the video for this unit, spend a few minutes thinking about some of the issues in this field, presented as questions on the handout. With another person, discuss or write a few thoughts or questions you have about each of these issues. After watching the video, go over them again as a group. Did your thoughts correspond to what you heard in the video? Were your questions answered?

Materials

- One copy of the list of Biodiversity Questions per person (master copy provided)

Biodiversity Questions

These questions represent some of the issues surrounding the science and politics of biodiversity. What are your thoughts on these issues?

1. How is biodiversity defined?

2. How is biodiversity measured?

3. What are some of the reasons to maintain biodiversity?

4. What is habitat fragmentation? What impact does it have on ecosystems and the community that includes humans?

5. How does the present rate of extinction compare to previous eras? What is the sixth mass extinction?

6. What factors contribute to the probability that a species will go extinct?

Activity 2: Quantifying Biodiversity

Based on video and online text content

45 minutes

Setup

One of the challenges confronting biologists who study biodiversity is how to measure and quantify diversity. In 1982, Terry Erwin used a "kill 'em and count 'em" method to estimate insect diversity in a tropical forest. (Read more in the Biodiversity online text, available at http://www.learner.org/channel/courses/biology.) As shown in the video, the current method is to use field measurements combined with mathematical models; this is the technique used in this activity.

Working in pairs, follow the step-by-step instructions on calculating a diversity index for an example population. Then, test the effects of habitat fragmentation on populations you will create, using small, colored objects to represent individuals of different species. Share your results in the post-activity discussion.

Materials

- One copy of the Worksheet for Quantifying Biodiversity with Diversity Indices plus Discussion Questions per person (master copy provided)
- Approximately 125 small colored objects to represent individuals in an ecosystem. For every two people, have five small items (e.g., strips of paper, toothpicks, matchsticks, colored candies, etc.) in each of five different colors (five red, five green, five white, etc.), for a total of 25 per two people.
- Tips and Suggested Answers

Worksheet for Quantifying Biodiversity with Diversity Indices plus Discussion Questions

Background

Imagine a section of marsh that contains 43 species of plants. In terms of numbers of species, it is more diverse than a neighboring section that contains only 26 species. Suppose, however, that in the section with 26 species, the species were all roughly comparable in numbers of individuals; and in the section with 43 species, a few species were prevalent and the rest were rare. Which section would then be most diverse?

Ecologists have used various indices as a means to quantify biodiversity. One simple index is the Simpson index.

To calculate this Simpson index, we need to know the number of individuals for each particular species (n) and the sum of those numbers (N).

$D = SUM (n/N)^2$

For example, in a community of three species where one species has 6 members, a second has 12, and a third has 42:

$D = (6/60)^2 + (12/60)^2 + (42/60)^2 = 0.54.$

So when we are calculating D, we are summing the squares of the proportion each species makes to the total.

D actually is inversely related to diversity. When D = 0 (its theoretical minimum), there is infinite diversity. When D = 1 (its maximum), there is no diversity as all of the individuals are from just one species.

Ecologists will often use the reciprocal of D, 1/D. This figure actually has meaning in that it is the effective number of species in the area.

In the case above, the effective number of species is 1/0.54 or 1.852. Although there are three species in this area, because one species is common and the other two are relatively rare there is less diversity than there would be if there were two equally frequent species. Two equally numerous species would have a D of 0.5 and 1/D of 2. The maximum number of effective species is equal to the actual number of species and is achieved only when all species are equally abundant.

Exercises

Some answers are in the Tips and Suggested Answers.

Exercise 1: Practice calculating diversity.

1. Calculate D and then the effective number of species in a community that consists of the following:

   Species A – 35

   Species B – 26

   Species C – 13

   Species D – 6

   Species E – 4

2. How does D for this scenario compare to the numbers worked out in the example? How does this population compare to the example population with three species where one dominates, or the example of two equally frequent species?

Exercise 2: Make (and fragment) a habitat.

1. Make an ecosystem using the colored items (e.g., the strips of paper, matchsticks, or colored candies) to represent individuals of five different species. Each pair will put in 25 items—five each of the five different colors—until the ecosystem is complete. Each color will represent a different species; for example, if there are five groups, there should be 125 total items.
2. Calculate D and the effective number of species for the total population.
3. In pairs, take a random sample of 25 items from the total.
4. In pairs, calculate D and the effective number of species for its sample.

Post-Activity Discussion

Each pair will share its results with the group.

1. Were the consequences of habitat fragmentation more or less severe than you expected?

2. In the ecosystem you made, the different colors represented different species. Imagine three of the colors were plants and two were animals. What effects would you expect in the fragmented communities that you created randomly? Reconsider the scenario with one object being a bacterium, one a flying insect, one a nematode soil worm, one a plant, and one a mammal.

3. What kind of practical steps can we take to reduce the fragmentation of habitats? What incentives might motivate developers and civic leaders to consider habitat fragmentation in urban planning?

Quantifying Biodiversity Exercises

Exercise 1: Practice calculating diversity.

D = 0.3 and the effective number of species is 1/D = 3.3. This population has a higher effective number of species than either of the previous examples.

Exercise 2: Make (and fragment) a habitat.

1. If your community has five different species, each equally represented, D = 0.2 and the effective number of species is 5.0.

4. Answers will vary, but D should be significantly higher and the effective number of species should be significantly lower than those values for the total. This demonstrates that sampling reduces diversity.

Activity 3: Extinction Risk

Based on video and online text content

25 minutes

Setup

As discussed in the text and seen in the video, many factors will influence the susceptibility of a species to becoming extinct. In this exercise, work in teams and discuss the likelihood of extinction for an imaginary species. Characteristics of the species and the online text will provide information about which of the species is more likely to go extinct.

Materials

- One copy of the Pairs of Species to Compare for Extinction Susceptibility plus Discussion Questions per person (master copy provided)
- One copy of the Biodiversity online text chapter per two people (available online at http://www.learner.org/channel/courses/biology)
- Tips and Suggested Answers

Pairs of Species to Compare for Extinction Susceptibility plus Discussion Questions

Answers are in the Tips and Suggested Answers.

Example 1:

Compare these species and decide which is more likely to go extinct. Consult the online text for more information on factors that determine extinction probability.

Ficolia nigra — The black bark beetle — Current population size is estimated to be 150,000 individuals. It is found in wooded areas over large sections of the Midwest and Central Plains, but is generally rare across its range. It can live in a variety of different species of trees.

Ficolia confusum — Resembling and often confused for *F. nigra*, this species is a specialist on birch trees. Its range, which is enclosed by that of *F. nigra*, is much smaller. *F. confusum* is usually found at higher altitudes than *F. nigra*. Where *F. confusum* is found, it is usually abundant. Estimated population size of 250,000 individuals.

Example 2:

Compare these species and decide which is more likely to go extinct. Consult the chapter text for more information on factors that determine extinction probability.

Silpera impratus is a small annual plant that occurs in and near marshland. This species is an obligate outcrosser: individual plants have either male or female flowers, but not both. Its population size is in the hundreds.

A related species, *Silpera stebbinsi*, occurs in similar habitat. Its population size is also in the hundreds. Unlike *Silpera impratus*, individuals of this species contain both male and female flowers. Selfing is common.

Discussion Questions

1. Are captive breeding programs useful in preserving endangered species? What are some advantages and disadvantages of these programs?

2. Climate changes can cause species to adapt to different environmental conditions. They may also lead them to be exposed to new sets of species as ecosystems shift and organisms migrate. What are some effects that might occur from reshuffling species assemblages?

Pairs of Species to Compare

Example 1: Both species are likely to persist given their large population sizes, but *F. confusum* may be at some risk because it has a more restricted range and a more restricted habitat.

Example 2: Both species face substantial probabilities of going extinct. *S. stebbinsi* is less likely to go extinct than *S. simpratus*, because the former's ability to self decreases the likelihood of going extinct via demographic stochasicity.

Activity 4: Concept Maps

Based on video and online text content

20 minutes

Setup

Biodiversity encompasses large issues in biology and social and political policy. Concept maps can be a useful tool for generating overviews and organizing thoughts on global topics like biodiversity. Work individually to draw concept maps using the suggested topics, and then discuss them with two or three other people. Add concepts to the maps as they come up in the discussion.

Materials

- One copy of the Suggested Concepts to Map per person (master copy provided)
- One copy of the Biodiversity online text chapter per two people (available online at http://www.learner.org/channel/courses/biology)

Suggested Concepts to Map

Build concept maps to show how the following groups of ideas might be related. Consult the online text for clarification of the concepts. Then, discuss the individual concept maps with two or three other people.

1. dilution effect, development, habitat destruction/fragmentation, zoonotic disease (has both human and animal hosts), species richness
   - How does Lyme disease illustrate the interactions in this concept map?

2. productivity (biomass), diversity, stability
   - Is a stable system one that doesn't change?

3. species inventory; extinction; sustainable practices; specimen collections, seed banks, and DNA banks
   - How might applying these concepts to animals or microorganisms differ from applying them to plants, as was shown in the video?

Activity 5: Wrap-Up Discussion

Based on video and online text content

15 minutes

Setup

In this brief discussion, review the reasons for preserving biodiversity, and consider the practical issues in creating policy and implementing preservation practices. As teachers, what issues will you bring to the classroom and in what context will you present them?

Materials

- One copy of the Discussion Questions per person (master copy provided)

Discussion Questions

1. List as many reasons as you can think of for preserving biodiversity. Which would you classify as utilitarian, and which would you classify as non-utilitarian? How would you define the difference between these classifications?

2. What factors, utilitarian or non-utilitarian, should be used to determine if an area warrants protection? How should the importance of those factors be determined and weighted in making decisions about developing or preserving an area?

3. Some argue that richer countries have a responsibility to help poorer countries preserve biodiversity. What are some ethical and economical reasons to support this position? Which are most convincing to you? Which are the least convincing? Why?

4. With the others in your group consider the concepts in this unit, and discuss how they relate to and inform concepts you currently teach. How might these concepts be used in a team-taught class with a civics or political science teacher?

Notes