



United Nations
Educational, Scientific and
Cultural Organization



United Nations Decade of Education for Sustainable
Development (2005-2014)

Learning about Biodiversity - Multiple-Perspective Approaches



Education for Sustainable Development in Action
Learning & Training Tools N°6 - 2014
UNESCO Education Sector

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U N E S C O

Education for Sustainable Development in Action
Learning & Training Tools N°6

2014

Published in 2014 by the United Nations Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75732 Paris 07 SP, France

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Initially developed in the context of the *UNESCO International Biodiversity Learning Workshop: Multiple Perspective Approaches to Biodiversity Education*, held at UNESCO Headquarters (Paris, 2-4 May 2012) by the workshop participants, the tool was finalized in the framework of the 'United for Biodiversity' – *Enhancing Biodiversity Conservation through ESD in UNESCO sites (Biosphere Reserves, World Heritage)* initiative.

Main target audience for this tool: secondary school teachers

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Cover design: Helmut Langer

ED/TLC/ESD/2014/PI/5

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I. A Multiple-Perspective Approach for ESD and Biodiversity

The Multiple-Perspective Tool is a valuable framework for teaching any sustainable development issue. The focus of this particular companion document is on applying multiple perspectives for Education for Sustainable Development (ESD) to biodiversity issues. Biodiversity is an important asset to sustainable development and has been identified as a priority by the UNESCO Member States, among other emerging and recurrent issues. Biodiversity is crucial for all living organisms and ecosystems. In addition, biodiversity is essential for human health and resilience, as well as for social and economic development. Political commitment, community action and many other factors including those influenced by cultural and academic disciplines signal the multiple-perspective value of biodiversity. Biodiversity is a shared resource, uniting people, communities and habitats across vast expanses of space and time. To educate for biodiversity, we must also educate about how it is valued, governed and reserved throughout the world.

Biodiversity [which also includes people and ecosystem services] is mainstreamed in an interdisciplinary way across many topics within the curriculum, while also being embedded into biology. The study of biodiversity is also offered as an extracurricular opportunity and in non-formal education (in natural history museums, zoos, aquaria, botanical gardens, parks, etc.) so that teachers and students can appreciate the intrinsic value of biodiversity, are aware of the importance of biodiversity for people and ecosystems, and are aware of the threats it faces, thus allowing them to make choices and take actions to improve the status of biodiversity.

Teaching through a multiple-perspective approach provides a valuable means to guide holistic thinking about complex systems, most specifically about environmental issues. A multiple-perspective approach conveys the dynamic parts-to-whole relationship, which constitutes complex systems such as the Earth's biodiversity. The many processes and events of both natural and human influences on biodiversity become accessible and meaningful to learners. Students are guided to understanding through eight unique, but overlapping, perspectives on the relationships within natural systems and between natural systems and human society.

The Multiple-Perspective Tool can be used as a pathway to:

- learn about sustainability issues from multiple bodies of knowledge,
- identify and understand personal and others' perspectives, and
- apply decision-making processes to complex issues that affect personal, community, and global well-being.

Complex issues related to biodiversity sustainability entail geographic, political, scientific, cultural, economic and social factors. By its very nature, teaching for biodiversity requires that multiple perspectives be applied when searching for solutions or good practices in biodiversity management. Individual students who have experienced a multiple-perspective approach have more opportunities to establish a sense of place, both in their local and global communities. Through local action and understanding the perspectives of others, students can better know themselves.

II. Using the Multiple-Perspective Approach for ESD and Biodiversity

1. Why Use Multiple Perspectives for ESD and Biodiversity?

As stated in the resolution launching the DESD, “education is an indispensable element for achieving sustainable development” (United Nations, 2002, p. 1). This is particularly true for biodiversity. For example, ESD can engage people through innovative ways of learning about biodiversity by focusing on education and training to address the interlinking issues of ecosystems and livelihoods, the interactions of nature with culture, society and economy, and the actions we can take without affecting our quality of life. The need to strengthen biodiversity education at all levels – informal, formal and non-formal – continues to receive increased attention in international initiatives.

2. Suggested Multiple-Perspective Instructional Strategies for ESD and Biodiversity

In this section, suggested instructional strategies and related Multiple Perspective questions, specifically designed for ESD teaching and learning about biodiversity, are provided. These examples are intended to be starting points for adaptation into specific classroom topics and communities. All of the strategies have been designed to build knowledge, skills and attitudes consistent with teaching and learning for ESD.

2.1 Scientific Perspective

What does learning about biodiversity through a scientific perspective mean?

A scientific perspective is based in collecting, analyzing, and interpreting empirical data about natural cycles and phenomena, understanding the dynamic equilibrium across biotic and abiotic components of the Earth, and applying empirical knowledge to solve problems.

A scientific perspective is assumed to be context-free, such that consideration of the other perspectives documented through the Multiple-Perspective approach would have no effect on the data or data analysis of a strictly scientific perspective. The scientific perspective maintains that scientific knowledge is “true” and useful in any setting.

Suggested Instructional strategies for learning about biodiversity through a scientific perspective:

Strategy 1. Students can undertake simple research of flora/fauna identification in their local area/country to facilitate their understanding of biodiversity in the locality. They should share the results so that students can measure the condition of biodiversity around the world. Students can also observe animals and plants in nearby parks and then outline their findings. Those findings can then be shared in class.

Strategy 2. Students can create a food chain using various forms of media (videos, pictures, drawings...)

Sample Questions: How can impacts of climate change effect this food chain? What is the significance of each member in the food chain? How can human behaviour affect it?

Strategy 3. Students can look for examples where biodiversity has been impacted by technological progress. This may be done via internet research or the use of real life examples.

Sample questions: How do these aspects of technological progress in agriculture affect biodiversity? (genetically modified crops, use of pesticides, use of herbicides, mechanization of agriculture). How do changes in fishing techniques or livestock raising techniques impact biodiversity?

2.2 Historical Perspective

What does learning about biodiversity through a historical perspective mean?

Learning about biodiversity through a historical perspective helps learners understand how natural or human-created biodiversity issues have been addressed over extended periods of time, as well as in the present. Learners should analyse responses to biodiversity issues within the context of available knowledge, technology, perceptions, or cultural expectations. Using evidence from past and current situations, learners should understand how local and global communities have made biodiversity management decisions and the implications of those decisions.

Suggested instructional strategies for learning about biodiversity through a historical perspective:

Strategy 1. Students can think about where they live and what it was like 50 years ago compared to today. They can also imagine a possible future scenario for their living environment, in terms of biodiversity. Pictures from 50 years ago can help describe the changes.

Sample Questions: Was the landscape the same? The animals, plants, foods, people? What do their grandparents say about biodiversity that used to be there but is no longer present, or things that are new that did not exist in the past? Have there been changes in how biodiversity is managed in the community? What were the results—good or bad? (hunting regulations, forest access rules, species introduced for amenity or sport, etc.) If you repeat the process for 100 years ago, was it different from the present and/or 50 years ago?

Strategy 2. Students can create multiple-tier timelines (chronologies) of significant biodiversity events (extinction of species, evolution of species) since the beginning of life on Earth.

Sample Questions: Is there a pattern of biodiversity-related events or phenomena that affects quality of life? Have protecting biodiversity decisions in a particular area been consistent over an extended period of time? What have been some long-term effects of past decisions?

2.3 Geographic Perspective

What does learning about biodiversity through a geographic perspective mean?

Learning about biodiversity through a geographic perspective helps learners understand how natural or human-created biodiversity issues appear and perhaps reoccur across a community, region, country, continent or Earth. Events (natural and human-caused) or challenges take on different complexities when examined at a local scale, national scale or international scale. By studying the geographic scale and recurrence of a problem, students gain deeper insights into the origin of the problem and potential solutions.

Suggested instructional strategies for learning about biodiversity through a geographic perspective:

Strategy 1. Students should get in contact with other students living abroad via the internet so that they can gather information on different ecosystems.

Sample Questions: How is climate change affecting our lives at global, national, and local levels? What plants are growing in their homes and yards? Could someone tell from looking at a photograph of those plants, where you are geographically? How different is biodiversity throughout the world?

2.4 Human Rights Perspective

What does learning about biodiversity through a human rights perspective mean?

A human rights perspective stresses the relationship between access to sufficient resources and opportunities to access other universal rights, notably education, health, and active participation in governance. Learners should understand how impacts upon biodiversity may affect access to natural assets, how human activities may improve or worsen a group's opportunities to fully participate in other universal rights, and how financial resources of individuals or communities may affect the impact of natural or human-made biodiversity issues.

Learning how the availability of human and institutional capacities, adequate governance affect biodiversity, may improve its preservation. In addition, a human rights perspective teaches how quality of life can be affected by the relative health of biodiversity. This requires that biodiversity is understood not as a purely economic good, but also as a social and cultural good.

Suggested instructional strategies for learning about biodiversity through a human rights perspective:

Strategy 1. Students should engage in discussions in which diverse peoples' needs and goals are represented in an effort to understand how different human rights are interrelated.

Sample Questions: Do certain groups within the population have more to gain from the protection of biodiversity? What are the implications for other facets of biodiversity? How does limited biodiversity affect people's ability to fully participate in educational, economic, cultural and other aspects of society?

Strategy 2. Students should list the resources their families depend upon and discuss the way in which resources are managed and how this may relate to human rights.

Sample Questions: How can people manage their rights so that it does not interfere with natural rights? (right to a healthy environment / right to share access to benefits of biodiversity / rights of humans but also rights of nature/ species). What are our responsibilities towards biodiversity?

2.5 Gender Equality Perspective

What does learning about biodiversity through a gender equality perspective mean?

During the learning process, learners explore how social and cultural practices regarding access and use of natural resources may affect men and women differently, including gender roles in relevant decision-making at different levels in using and protecting biodiversity in different communities.

Learners can also consider how access and long-standing practices related to resources, especially for domestic use, may have contributed to unexamined consequences of traditional gender roles, including differential access to education and work opportunities. Students may consider, too, how advances in biodiversity management (e.g. technology) may have changed the context for traditional biodiversity-related gender roles (e.g. technology has replaced the need for physical strength in completing many tasks).

Suggested Instructional strategies for learning about biodiversity through a gender equality perspective:

Strategy 1. Students should list the ways in which men and women are affected differently/in the same way by biodiversity, in their community, as well as in other countries.

Sample Questions: Are there gender roles in society? For example, are different responsibilities, tasks, or recreational activities undertaken by mainly one gender? (Example: hunting in

Europe = men, seaweed gathering in Indian Ocean = women) Is there specific knowledge of biodiversity used by one sex more than the other? (In some cultures women collect medicine from forests and know how to use them to treat illness). Do men and women eat exactly some food? If not, please explain why?

Strategy 2. Students will research how accepted habits of protecting biodiversity affect participation in various aspects of community life; including school, commerce, and governance. Students will document daily tasks of their own family members, over an extended period of time (perhaps two weeks). Students would then aggregate the data with those of their classmates, to look for gender-related work patterns.

Sample Questions: What lifestyle or societal practices does one gender practice that may impact more their protection of biodiversity? How much flexibility exists in a particular community for people to go beyond accepted gender roles? Can assumptions about gender roles limit peoples' contributions to society? Are biodiversity conservation practices in the community gender sensitive?

2.6 Values Perspective

What does learning about biodiversity through a values perspective mean?

Learners understand how particular needs or perspectives that an individual or group holds can dominate their ideas on biodiversity. Learners should recognize that participatory discussions about biodiversity should seek understanding across different values, with the goal of finding a consensus position or action.

Suggested instructional strategies for learning about biodiversity through a values perspective:

Strategy 1. Students can participate in a town council meeting regarding local biodiversity protection issues. For information on the instructional strategy of a town council, see Additional Resources section in the Multiple-Perspective Tool on Structured Academic Controversy. Students can first document the values perspective of each speaker, then, using a graphic organizer (such as a Venn diagram) make connections about which values are mutually supportive and which seem to be mutually exclusive. Finally, students can suggest possible solutions which acknowledge and respect the values expressed during the town council meeting, in an attempt to move the community toward a common course of action.

Sample Questions: Example of town council meeting: The city nature park is famous in the region for both historical and natural reasons (historic battles took place and some rare species were found here). The local plant society has been removing non-indigenous plants to give the rare natives more space to grow. However, to commemorate the battlefield, city gardeners recently planted 50 non-indigenous trees which produce small fruits that attract birds. So what should the council do? Take out the new non-native trees or leave them?

What diverse values are evident among the local community? Which value systems are most consistent with collaborative approaches to problem-solving? Do the different value systems indicate a worldview where humans are seen as stewards or consumers of natural resources? How can differing value systems be respected, while finding a single solution to a regional biodiversity concern?

Strategy 2. Students should read a series of statements on biodiversity management issues. As each question is read, students can indicate the degree to which they agree or disagree with the statement. After students have responded independently to each question, they can discuss their opinions with small groups of fellow students. Students should be guided to explain their positions and to ask their classmates why they feel the way they do.

Sample Questions: Did you see a pattern in your responses? How would you describe your values in regard to biodiversity as a resource? As you listened to your classmates explain their responses, did you change any of your opinions? What did you learn from listening to others' explanations? Do all people share innate universal human values?

Strategy 3: Students should explore personal and biodiversity values. Students should then discuss how values inform decisions and action as well as compare values behind sustainable development and conventional development.

Sample questions: What are the student's values regarding the environment/biodiversity in their own community and globally? How were student's values formed (innate, family, religion, culture, school, etc.) and how were they changed (if they were)? What is/are the value(s) of biodiversity?

How do one's values inform the decisions and actions that one makes? How have past decisions impacted the community? How do current decision and actions impact the future? Given the many values of biodiversity (not an exhaustive list): intrinsic, aesthetic, recreational, source of human values, spiritual, please rank [from a list of 20 species given or one's own list] from most to least important. Why does one place a particular species higher or lower in the ranking? Is it because of one's values?

2.7 Cultural Diversity Perspective

What does learning about biodiversity through a cultural diversity perspective mean?

Learners understand that biodiversity issues may be interpreted through unique worldviews that are created through aesthetic, empirical, or transcendent ways of knowing. A cultural perspective is often a unique perception associated with a particular community, which may serve to separate that community from other cultural communities. A cultural diversity perspective considers the role of biodiversity in the cultural community's worldview.

Suggested instructional strategies for learning about biodiversity about biodiversity through a cultural diversity perspective:

Strategy 1. Students may use primary sources from several distinctive cultures (e.g. where biodiversity is abundant or lacking; protected or ignored) to understand the values attributed to biodiversity in societies. Primary sources can include oral and written stories, songs, poetry, and other forms of cultural expressions. Students can then compare and contrast the underlying values as expressed through the primary sources to interpret each culture's assumptions and values regarding biodiversity, as a part of their worldview, a resource, etc. If combined with a historical perspective, such comparisons may also be made within one given society, at different periods of time.

Sample Questions: What contributions of unique cultural groups have affected biodiversity as a resource? What cultural traditions are symbolic of the role of biodiversity in people's lives? What values regarding biodiversity do customary practices convey? Does every festival/cultural activity in the students' communities relate to natural resources? If there are specific species in that cultural activity, please specify. What is the importance of using natural resources in those festivals or cultural events?
Has there been any change in a natural resource over the last ten years when it has been used in a cultural activity? Does the students' community have a special day to mark the beginning of the agricultural season/spring? What symbols are used?

Strategy 2. Students will consider biodiversity-related issues which embody a moral or ethical dilemma. Students will take part in a town hall-styled discussion, in which groups of students impartially take on distinct roles, including religious and/or moral. (Eg. Can slash-and-burn agriculture be accepted in an area which constitutes important religious significance for the neighboring community and is also inhabited by a rare species of bird?)

Sample Questions: Should economic development be pursued in areas that many believe to have religious significance? If the permit is granted, what are the implications for respect of diverse religious beliefs? for biodiversity protection? If the permit is denied, what are the implications for economic and agricultural development in other areas?

2.8 Sustainability Perspective

What does learning about biodiversity through a sustainability perspective mean?

Learners consider the interactions between the environment, economics, and society to ensure sustainability for ecosystems and people today and for future generations.

Quality of life issues should be considered in the context of natural and human-made resources. All societies need biodiversity to maintain a quality of life consistent with universal human rights. Projected needs of future generations should also be considered, with planning for future use and growth as integral components of sustainability decisions.

Suggested Instructional strategies for learning about biodiversity through a sustainability perspective:

Strategy 1. Students should discuss how their lifestyle is impacting biodiversity preservation as well as other aspects of environment protection. Students should also list at least ten ways in which they are dependent on biodiversity.

Sample Questions: How can trees be harvested with minimal impacts on the ecosystem? How do activities in one part of a waterway affect biodiversity and the ecosystem? Why are some ecosystem services provided by biodiversity that are essential for cities? For farmland? How have the students affected biodiversity today? What products have they used? How do they impact/relate to biodiversity? (paper, chalk, clothing, breakfast, how students got to school). How can we insure that future generations will have fish to eat? What is one thing you could do to would destroy a lot of biodiversity?

III. Sample Lesson Plans

1. Biodiversity Documentary Viewed Through Multiple Perspectives

DESCRIPTION: In this activity, students will share a common experience by watching the same documentary focused on biodiversity. However, they will view the film from different perspectives and share their insights, giving the entire class a multiple-perspective assessment of the issue.

TEACHING TECHNIQUES: film/media, “jigsaw” cooperative learning, class discussion

OBJECTIVE: To learn about biodiversity from various perspectives through the use of media

MATERIALS: Documentary (from provided list in Resources section); worksheets of questions for various perspectives

TIME: 60-90 minutes

TEACHING SEQUENCE:

- Divide the class into 3-8 groups of equal numbers of students. Assign each group a different perspective (e.g. values, historical, sustainability, etc.).
- Distribute to each student a worksheet that pertains to his/her assigned perspective.
- Explain to the students that, as they watch the documentary, they should individually respond to the questions on the worksheet based on their assigned perspective.
- Watch the documentary.
- At the end of the film, allow students 5-10 additional minutes to complete their worksheets individually.
- Instruct students to form groups with the others from the same perspective – their “home” groups. Allow the groups 10-15 minutes to discuss their findings and compare responses. Encourage students to talk about what surprised them and what concerned them in the documentary, based on their perspective.
- Discussion questions for the single-perspective “home” groups:
 - How is biodiversity presented in the documentary?
 - How is biodiversity viewed through your assigned perspective?
 - What did the documentary address regarding your perspective?
 - What was left out?
 - What changes would you suggest to the filmmakers?
- Divide students into new “expert” groups where one representative from each “home” group is present. This can be done by assigning each student in the “home” group with a number and then designating a location in the classroom for all of the “1s” to gather and all of the “2s” to gather, etc. In these “expert” groups, allow 10-15 minutes for further discussion and comparison.
- Discussion questions for the mixed-perspective “expert” groups:
 - What was the primary goal of this documentary?
 - Which perspective was the most clearly addressed in this documentary?
 - How does the role of biodiversity change or vary depending on the perspective used?
 - Were there any perspectives that were not considered?
 - What did you learn about biodiversity? About the multiple perspectives?
 - What would you change?
 - What concerns do you have watching this documentary from your perspective?
- A discussion with the entire class can follow if necessary.

CLOSURE: How has this documentary changed *your* personal perspective of biodiversity?

EVALUATION: Listen to the responses of the group discussions and the closure, which can also be a written assignment to leave time for reflection. The answers are revealing of student understanding.

EXTENSION: Ask students to design their own documentary about biodiversity. What would they include? Who would they interview? What images would they show? Who would be the intended audience? What perspectives would they include and why? How would their documentaries differ from the one they just watched in class?

SOURCE: Saskatoon Public Schools. 2009. What is Jigsaw? *Instructional Strategies Online*.

2. Biodiversity Case Study Explored Through Multiple Perspectives

DESCRIPTION: In this activity, all students will read the same case study focusing on a particular biodiversity topic. They will analyze the case study through the lens of a specific perspective. Students will then share their findings with their peers. This activity allows for the investigation of an issue at various levels and from various points of view.

TEACHING TECHNIQUES: Case studies, reading comprehension, “jigsaw” cooperative learning, class discussion

OBJECTIVE: To learn about biodiversity from various perspectives through the use of case studies

MATERIALS: Case study (from provided list in Sample Case Studies section); worksheets of questions for various perspectives

TIME: 45-60 minutes

TEACHING SEQUENCE:

- Divide the class into 3-8 groups of equal numbers of students. Assign each group a different perspective (e.g. values, historical, sustainability, etc.).
- Distribute to each student a worksheet that pertain to his/her assigned perspective.
- Explain to the students that, as they review the case study, they should individually respond to the questions on the worksheet based on their assigned perspective.
- Distribute and read the selected case study. This can be done in a number of ways: 1) teacher reads out loud while students follow along with their own copies; 2) students read individually; 3) students read in small groups; 4) students take turns reading out loud.
- After an initial reading of the case study, allow students 15-20 additional minutes to review the case study again and complete their worksheets individually.
- Instruct students to form groups with the others assigned the same perspective – their “home” groups. Allow the groups 10-15 minutes to discuss their findings and compare responses. Encourage students to talk about what surprised them and what concerned them in the case study, based on their perspective.
- Discussion questions for the single-perspective “home” groups:
 - What is the role of biodiversity in the case study?
 - How is biodiversity portrayed through your assigned perspective?
 - What did the case study address regarding your perspective?
 - What was left out?
 - What would you change?
- Divide students into new “expert” groups where one representative from each “home” group is present. This can be done by assigning each student in the “home” group with a number and then designating a location in the classroom for all of the “1s” to gather and all of the “2s” to gather, etc. In these “expert” groups, allow 10-15 minutes for further discussion and comparison.
- Discussion questions for the mixed-perspective “expert” groups:
 - Which perspective was the most clearly addressed in the case study?
 - How does the role of biodiversity change or vary depending on the perspective used?
 - Were there any perspectives that were not considered?
 - What did you learn about biodiversity? About the multiple perspectives?
 - What would you change?
 - Do you have any concerns about this case study based on your perspective?
- A discussion with the entire class can follow if necessary.

CLOSURE: How has this case study informed you and changed *your* perspective of biodiversity?

EVALUATION: Listen to the responses of the group discussions and the closure, which can also be a written assignment to leave time for reflection. The answers are revealing of student understanding.

EXTENSION: Encourage students to write a case study about a biodiversity issue in their own community or a community that they research. What elements would be important to include? How much background information is required? Who is the intended audience? What is the issue they are trying to convey? How do multiple perspectives play a role?

SOURCE: Saskatoon Public Schools. 2009. What is Jigsaw? *Instructional Strategies Online*. <http://olc.spsd.sk.ca/de/pd/instr/strats/jigsaw/index.html>

3. Local Problem, Global Impact: A Community Project on Biodiversity

DESCRIPTION: Relevance to students' personal experiences is considered one of the key elements of learning. In order to make global issues more meaningful and understandable to students, this project will use a community biodiversity issue to delve deeper into what this means on a local and global level, investigated through a variety of perspectives. Using their own community as a case study will help students fully grasp the concept of biodiversity.

TEACHING TECHNIQUES: hands-on, interviews/inquiry, research, class discussion, brainstorm

OBJECTIVE: To understand a local biodiversity issue and to utilize a variety of research methods to determine how biodiversity impacts the community.

MATERIALS: variable, depends on each group

TIME: variable; up to 2 weeks

TEACHING SEQUENCE:

- Explain to the students that they will be working on a multi-day project that focuses on their own community. This project will be selected and designed by the students; however, the project must be related to biodiversity and the research activities must utilize the multiple perspectives.
- Lead the students in a brainstorming activity to help them begin formulating ideas about a potential project topic. As a whole class, encourage students to suggest ideas of biodiversity-related topics that they have observed or experienced in their community. Write their ideas on a blackboard or piece of paper. If students need more time to think, give them the assignment to go home and talk with their families about other ideas.
- Once a lengthy list has been produced, discuss with the class the feasibility of the various ideas, ruling out the ones that would require too much time, are unsafe, etc. Consider rating topics according to the importance of each to the community. Vote as a class for the top project idea to pursue.
- When a project has been chosen, begin coordinating tasks. Assign students to small groups that will each take on a research assignment related to the biodiversity topic, focusing on a particular perspective. Each group will be responsible for 1) defining the questions that they would like answered and 2) developing a method by which they obtain the necessary information. Potential group task ideas:
 - **Scientific:** Research (via library and/or data collection) and compile information about the biodiversity topic. What is happening to the environment, people and economy because of it? What are the implications for the community?
 - **Historical:** Research the biodiversity topic in books, newspapers, online, at the local Historical Society, etc. Determine how the issue has progressed and how the community has responded.
 - **Geographic:** Visit a biodiversity site if possible. Using a plan of the site as a base, draw a detailed map of the biodiversity elements, highlighting key features. Students could meet with a local official or another member of the community who knows the biodiversity site well. Have there been any other regions around the world that have experienced a similar issue?
 - **Human Rights:** Research biodiversity-related rights and community policies. Speak with a local lawyer about biodiversity issues and learn about what this means for the community members.
 - **Gender Equality:** Interview men, women and children who live by or are affected by the biodiversity issue. What do they experience? What has changed? What would they like to see happen?
 - **Values:** Survey the community members at large to determine how important protecting biodiversity is to them compared to other aspects of environment protection.

- **Cultural Diversity:** Interview community members of different ethnic backgrounds about their views and beliefs regarding biodiversity. Write short stories about each person interviewed. Do different ethnic groups in the community see biodiversity differently? Do different ethnic groups in the community perceive or celebrate biodiversity in different ways?
- **Sustainability:** Think strategically about the impact and consequences of this biodiversity issue on the community. What are the major risks and consequences to the natural environment? What are the major risks and the consequences to human systems? What are the economic implications? What are the major currently implemented or proposed solutions? What are the obstacles to these solutions?
- Assign students a deadline for completing a report about their findings. (in-class time will be needed over the course of the project), When students have completed their respective assignments, the small groups can report to the entire class. The reports, depending on their assignments, can be in multiple forms – oral (e.g. radio reports), written (e.g. newspapers articles), maps, murals, etc.
- Allow each group to present its final report to the rest of the class.
- As a class, discuss what all of the pieces mean when they are brought together.
- Discussion questions:
 - How is this biodiversity issue affecting the community as a whole and parts of the community?
 - What has changed over the years?
 - What are the potential implications if nothing is done to correct the problem?
 - What are your recommendations for this community biodiversity issue?
 - How does this impact the communities around yours? The country? The world?

CLOSURE: Students should write a reflection of their experience throughout this community project. Some potential questions to consider: What have you learned about your community and its biodiversity and ecosystems? Where did you learn the most information? Were you surprised by any information sources? What is a change you can make or have made in your daily life to lessen the issue? Beyond changes in your daily life, what is the next step you could take to address the issue?

EVALUATION: Review the group reports, presentations and the closure reflection writing activity. Listening to the group discussions and holding group meetings over the course of the project are also tools for assessing student understanding.

EXTENSION: Assist the class in drafting one final report based on the findings of each smaller group. With this final report, include the students' recommendations of steps to take to correct or improve the issue. Schedule an appointment with the appropriate town official so that the students can present their report.

SAFETY: All interviews, trips and ideas should be discussed with the teacher beforehand to ensure safety and legality. It is recommended that the teacher have regular meetings with each small group periodically throughout the course of the project.

IV. Sample Case Studies

Several sample case studies of global biodiversity issues will need to be developed from different sources, using the Case Studies Template in the annex.

Each case study has a challenge problem for students to attempt to resolve and discussion questions from each of the perspectives. While these case studies may prove to be useful in generating critical thinking, they too are considered a starting point for the teacher to design locally relevant Problem-based Learning and Place-based Learning scenarios.

1. The case of the missing golden chanterelle

Abstract

When we discuss biodiversity we sometimes forget that the term covers not only different levels of complexity, but also that at the level of organisms it includes more than just plants and animals, but all forms of life including microscopic forms. Many fungi are visible, some are economically and socially important and all are important for ecological reasons. Some fungi seem to be declining and a few are even listed as endangered. The golden chanterelle (*Cantharellus cibarius*) is used as an example of a declining, ecologically, socially and economically important edible fungus.

General challenge

Fungi—which include mushrooms, moulds and yeasts—have been ignored, used or even feared in many cultures. All fungi play essential roles in their ecosystems and these roles directly or indirectly affect local people. Scientists think that some species may be endangered due to habitat loss, pollution, climate change, collecting methods, and lack of protection. But what do we lose if we lose one or many species of fungi? How does that affect other species and us? What can we do to save them?

Specific challenge

What are fungi? Like animals, to which they are more closely related, they digest food rather than making it themselves as plants do. They have rigid cell walls made of chitin, grow in long single filaments (hyphae) that comprise the fungal body (mycelia) and reproduce by a wide diversity of spore types. Some fungi are “tree companions”, having a relationship with trees to exchange nutrients. Other species are recyclers of dead materials such as fallen branches, dung or corpses, and others still are parasites on living animals, plants or other fungi. In many countries mushroom collecting has been a traditional activity. But in some areas where edible fungi used to be common, they no longer are. The golden chanterelle (*Cantharellus cibarius*), is on red lists in countries even as it continues to be a prized edible worldwide. Scientists think habitat loss and pollution, particularly nitrogen deposition, are to blame. But collecting techniques also may play a role, as the mycelia in the soil are very delicate. And worse, chanterelles are tree companions so if they are endangered some forest trees may be harmed as well. What can we do to save them?

For photograph and basic information on golden chanterelle:

http://botit.botany.wisc.edu/toms_fungi/july97.html

Geographic and temporal scale

Fungi live everywhere, including Antarctica and the ocean. But chanterelles live only with their partners, usually conifers or oaks. They are most common in North America, Europe and temperate Asia, although they also are found (and eaten) in Central and South America, Africa, the Middle East and Australia. While the edible mushrooms are only visible for a brief time each year, the mycelia lives

underground for many years. Trees must reach about 40 years of age before their partner chanterelles will fruit. It can take decades for polluted soils to decontaminate naturally, although topsoil removal speeds the process.

For a global map showing distribution of chanterelle species see table 3 in: <http://www.fs.fed.us/pnw/pubs/gtr576.pdf>

Perspectives

Historical perspective: Although the number of mushrooms varies yearly due to weather, the continued decline of chanterelles in goes back half a century. Today, in places where they remain common, there can be strong competition to collect them for global markets. Through the 1990s local governments in many European countries began to set up permits for personal and commercial mushroom collecting, with day closures, weight limits and banning damage to the mycelia. In North America parks or forests have their own permits, mostly set up in the 1990s and 2000s. Such legislation only addresses collecting. In the European Union legislation since 1980 has continued to strengthen long-range air pollution regulations and this has vastly improved the situation of acid rain and forest die back, so chanterelles have begun to return to some affected European forests. However, regulations and incentives are still needed to address the improper use of artificial nitrogen fertilizers and curb the release of greenhouse gases. Since the 1990s national red lists of species of concern have been established, as have National Biodiversity Strategies and Action Plans (NBSAP) under the 1992 Convention on Biological Diversity. But fungi are rarely found in these. It wasn't until 2010 that the International Union for the Conservation of Nature set up the first species survival commissions for fungi.

European Mycological Association paper with good reference list: http://www.wsl.ch/eccf/Guidance_Fungi.pdf

Scientific perspective: Fungi are very hard to identify without a microscope to see their species-specific spores (reproductive bodies smaller than plant seeds), or special laboratory processes to compare their DNA. Even ones we think we know sometimes turn out to be look-alike new species. There are over 99,000 described species but scientists think there may be over five million in all. And if some of the ones we know are endangered, it is likely that some of the ones we don't know also are. We do know that many other living things need to have their fungal companion (symbiont): cows can't digest fibre well, so it is their rumen fungi that do that for them; grasses have VAM fungi inside their blades; trees roots have fungi that create a shared tissue called a mycorrhiza. Other species of fungi such as inky caps are essential to break down organic matter into the basic building blocks needed for new life—they are nature's recyclers. Finally, there are parasites on plants, like rusts and smuts; on insects like cordyceps or laboulbenia; or on fungi like the parasitic bolete or lobster fungus. From tiny springtails to mighty elk, many animals eat fungi, and for some, like flying squirrels, bettongs, some beetles and flies, it is almost their entire diet.

The Fungi: 1, 2, 3 ...5.1 million species? <http://www.amjbot.org/content/98/3/426.full>

In the 1980s scientists were able to record a decline of fungi in Europe dating to the 1950s. Experimental and field data suggested that pollution might be to blame. For the golden chanterelle, there was a strong correlation between acid rain (caused by burning high sulphur coal for electricity generation) and fungal decline and between old-growth forest loss and fungal decline, although it was also thought that the forest decline itself might be due to pollution. But experiments proved that over-picking was not the direct cause of decline. The wide variety of factors, and the complexity of the relationship between fungi and trees, including their hidden underground connection, makes experiments challenging. In this century, climate change has been added as a new stressor to fungi. As it warms, species are fruiting earlier in the year and for a longer time, and are being lost from the hottest parts of their range. Tree ranges are also changing due to climate change, and companion fungi need to move together with them, although it is unclear how easy this will be. In 2007 European

mycologists reported that the main threats are loss of habitat (old-growth forests, fallen dead wood, standing ancient trees, and unfertilized grasslands), habitat fragmentation and nitrogen fertilizer use on nutrient-poor soils.

Guidance for Conservation of Macrofungi in Europe: http://www.wsl.ch/eccf/Guidance_Fungi.pdf

Social perspectives: In many countries there are traditions of annual mushroom gathering in the countryside by the whole family. Some towns have an annual mushroom festival or even festivals just for chanterelles, as near Bologna, Italy and in Big Sur, California. Yet, in other countries, like Great Britain, mushrooms were historically considered in a negative way. There is even mushroom tourism based on shared humanistic values between cultures. As mushrooms grow scarcer, the cultural traditions may be lost, and the older generation may not have opportunity to pass on their knowledge of which mushrooms are good for medicine, dyes or food. In cases where mushroom gathering is an important source of food or income, it can be a serious economic blow as well. In fact, chanterelles are picked all over the world and shipped to markets in Europe or Japan. In most countries there does not seem to be any difference in how women and men access and use fungi, with collection being a family activity, but this varies; in Tanzania they are mainly collected by women and children while in China it is mainly men. Mushroom brokers may truck in migrant harvesters from outside and pay them low wages for the fungi that enrich only the brokers—not the harvesters or the residents. Residents may then complain, even if there are no clear regulations about ownership or collecting, and violence has been recorded.

Mushroom tradition in Japan: <http://homepage2.nifty.com/shizen/recreation/mushroom.html>

Annual fair in southern France: <http://www.mycologiades.com/>

Mushroom tours in Canada: <http://www.outdoordiscoveries.com/mushroomtours.htm>

Wild Edible Fungi: a global overview of their use and importance to people. Eric Boa. FAO Forestry Department. Rome, 2004. <http://www.fao.org/docrep/007/y5489e/y5489e00.htm>

Sustainability perspective: Many plants don't grow as well without their fungal companions. In fact, over 80% of all plants, and many animals, have fungal symbionts, including some livestock and crops. If we lose a fungus, we could lose some of their partners, or animals that depend on them for food. There are termite and ant species that tend "fungus farms" upon which they are entirely reliant. Some fungi can help clean up pollutants or poisons in soil and water due to their specific decomposition abilities; others help control insect pests, recycle nutrients in soils or restore forests. We can grow nutritious edible species on waste materials like rice straw. Economically, chanterelles are big business and their possible loss would lead to a shift first to other species of edible fungi, and then to other income opportunities. Many important medicines have come from fungi, and we don't know what future medicines may be discovered. We could lose these ecological and economic benefits if other fungi species are lost.

Fungi and Sustainability: <http://www.fungimag.com/spring-08-articles/sustainability.pdf>

Paul Stamets 18 minute video "six ways fungi can save the world":
<http://www.youtube.com/watch?v=5gUSyKTCx4>

Values perspective: One chanterelle species is actually the "State Mushroom" of Oregon, USA. This demonstrates how much the citizens value the Pacific golden chanterelle (*Cantharellus formosus*). Historically, other species of fungi have been suggested as the origin of religions, or as a food for the gods, in early cultures as different as those of Mexico, Siberia, Greece or India. Fungi are common in folk tales, and are a source of wonder as they seem to pop up so quickly. However, it is economic values that are fundamental to creating the problem of endangered chanterelles. The air pollution that caused the acid rain, nitrogen deposition and forest die back in parts of Europe is a by-product of industrialization. The over-collecting is due to the high economic value of chanterelles. When they

became scarce, their economic value increased, thus encouraging mushroom brokers to “follow the harvest”.

Oregon State Mushroom:

<http://www.statesymbolsusa.org/Oregon/StateMushroomChanterelle.html>

Potential actions and solutions

Until recently there were no organisations for the conservation of fungi, but in 2010 the International Society for Fungal Conservation was created. It highlights that international laws about biodiversity and the NBSAP need to include fungi. Such international and national actions help lobby governments and industry to change practices that will make development more sustainable, and to consider fungi in forest management and in conservation planning, so that their habitat needs are met in new forests and protected areas. It is possible that commercial ways to grow chanterelles will be developed, thus placing less pressure on wild ones and creating new business.

You can ensure that if you collect mushrooms—with an adult expert—that you don’t disturb the mycelia, that you use a woven basket so spores can be released, and that you follow all local regulations. You can help scientists to collect data on local fungi by participating as a “citizen scientist” in any local clubs that do surveys near you. There are not enough mycologists to do all the work and they welcome your help.

Some citizen science links:

<http://www.rbg.vic.gov.au/fungimap/home>

<http://www.britmycolsoc.org.uk/education/public-outreach/past-events/big-nature-day/>

<http://depts.washington.edu/uwbg/news/tag/mushrooms/>

<http://www.mykoweb.com/PtReyes/index.html>

<http://www.opalexplornature.org/AirSurvey>

You can learn to grow some edible fungi at school: *Fun with fungi: the edible school yard -*

<http://edibleschoolyard.org/esy-berkeley-journal/2012/05/23/fun-fungi>

Concluding remarks

As fungi have amazing forms and lifestyles, we hope you will study them more. Some fungi are endangered because of habitat loss, pollution, climate change, improper collecting practices and lack of legal protection. Although some threats are complex, we at least can easily solve the last two by enacting regulations. Lifestyle changes that address sustainable development in general will benefit fungi—and fungi can benefit sustainable development. We need to learn which fungi are in trouble and try to protect them and their habitat. To do that, we first need to identify them. Many more species wait to be discovered...maybe by you!

Questions

➤ Can you name two examples of fungi having each of the following lifestyles?

a) Nature’s recycler (saprobe) [some of the possible answers: cannonball fungus; polypores like turkey tail; chicken of the woods; puffball, common button mushroom]

b) Parasitic on plants [some of the possible answers: huitlacoche; rust, wilt, honey mushroom]

c) Parasitic on animals [some of the possible answers: cordyceps; laboulbenia; chytrids, candida]

d) Tree companion (mutualistic) [some of the possible answers: bolete, morel, milky cap, russula, glomus, truffle, tirmania]

How does their lifestyle affect their role in the ecosystem?

- Where you live do people generally like to collect and eat wild fungi or not? Does your family collect them? If yes, do you know how the tradition started?
- Is there a popular fungus species in your region that is disappearing? If so, what is its name, its lifestyle and what has been done about to protect it so far? What more do you think should be done?

[some other examples of popular fungi that are endangered include caterpillar fungus or cordyceps (*Ophiocordyceps sinensis*), lion's mane (*Hericium erinaceus*) and matsutake (*Tricholoma matsutake*)]

- What are the local regulations protecting fungi in or near your community?

Definitions

Fungus: a life form that cannot make its own food but absorbs it, reproduces by spores, and is either unicellular (such as yeast), or made up of cells with nuclei, developed into a diffuse body of mycelia; plural fungi.

Mushroom: a fleshy, sometimes tough, umbrella-like fruiting body of certain fungi in the phylum *Basidiomycota*. More generally, the fruiting body of a fungus.

Spore: a minute propagative unit functioning as a seed, but without containing a pre-formed embryo. They can be formed either sexually or asexually.

Hypha: the tubular filament that is the basic structural unit of most fungi; plural hyphae

Mycelium: a mass of hyphae that makes up the body of the fungus; plural mycelia

Saprobe: an organism that uses dead organic matter for food.

Parasite: an organism that lives at the expense of another, usually invading it and causing disease.

Symbiont: a member of a close and often long-term interaction between two or more different species.

Mycorrhiza: a symbiotic association between the hyphae of certain fungi and the absorptive organs, typically the roots, of plants.

Warning: Some fungi species are poisonous, including ones that look similar to chanterelles. Never eat any mushrooms you find yourself unless an adult expert has identified it as edible.

References

From Another Kingdom: The Amazing World of Fungi. Lynne Boddy and Max Coleman, eds. Royal Botanic Garden Edinburgh, 2010.

Guidance for Conservation of Macrofungi in Europe. Beatrice Senn-Irlet, Jacob Heilmann-Clausen, David Genney, and Anders Dahlberg, European Mycological Association. 2007: http://www.wsl.ch/eccf/Guidance_Fungi.pdf

Field Guide: Mushrooms of Southern Africa. G.C.A van de Westhuizen and Albert Eicker. Struik Publishers Ltd, Cape Town, 1994.

Introductory Mycology Fourth Edition. C.J. Alexopoulos, S.W. Mims, M. Blackwell. John Wiley & Sons, Inc., New York, 1996.

Mushrooms Demystified Second Edition. David Arora. Ten Speed Press, Berkeley, CA, 1986.

Wild Edible Fungi: a global overview of their use and importance to people. Eric Boa. FAO Forestry Department. Rome, 2004: <http://www.fao.org/docrep/007/y5489e/y5489e00.htm>

Managing Forest Ecosystems to Conserve Fungus Diversity and Sustain Wild Mushroom Harvests. David Pilz and Randy Molina, eds. USDA Forest Service, Portland, Oregon, 1996.

Ecology and Management of Commercially Collected Chanterelle Mushrooms. David Pilz, Lorelei Norvell, Eric Canell and Randy Molina. USDA Forest Service, Portland, Oregon, 2003: <http://www.fs.fed.us/pnw/pubs/gtr576.pdf>

"A Preliminary Report on the Conservation Status of Fungi in the United States". L. Anathe Brooks. University of Maryland, College Park. 1994.

International Society for Fungal Conservation: <http://www.fungal-conservation.org/>

"Atmospheric pollutants and ectomycorrhizae: more questions than answers?" *Environmental Pollution* special issue. J. Dighton and A. E. Jansen. 1991. 73:179-204.

"Species migration and ecosystem stability during climate change: the belowground connection." D. A. Perry et al. 1990. *Conservation Biology* 4:266-274.

Teaching Resources

How the Mushroom Got Its Spots: an explainers' guide to fungi. Sue Assinder & Gordon Rutter, British Mycological Society. 2005:

http://www.fungi4schools.org/mushroom_pages/SPOTS_page02.htm

Additional British Mycological Society materials for the classroom: Fungi 4 Schools:

<http://www.fungi4schools.org/> and in particular "Thank Fungus For That"

North American Mycological Association educational resources: <http://www.namyco.org/education/index.html>

A Spanish site with useful information in a silly format: <http://www.pelo-pico-y-flor.com/micologia/>

Good photos for young students of symbioses between fungi and plants or animals: <http://www.morning-earth.org/Graphic-E/SymbiosisCrossKingFungi.html>

Resources

A selection of resources are listed here as a starting point for teachers to use in their classrooms with the Multiple-Perspective Tool. Searching on internet will provide you with many more interesting resources that may be more relevant to your local or national contexts.

General Websites

2010 International Year of Biodiversity – www.cbd.int/2010/welcome/

Australian ACT Initiative: Biodiversity – www.sustainableschools.act.gov.au/biodiversity

Biodiversity - What on Earth is it? – www.bbsrc.ac.uk/biodiversity/biodiversity-index.html

Biodiversity, The Majesty of Life – www.panda.org/about_our_earth/biodiversity/

David Suzuki Wildlife & Habitat – www.davidsuzuki.org/issues/wildlife-habitat/

Looking Forward to International Year of Biodiversity in 2010 – www.ec.gc.ca/Envirozine/default.asp?lang=En&n=5EC385CB-1

“See the Bigger Picture” Initiative – www.seethebiggerpicture.org/biodiversity.php

Global Issues: Biodiversity – www.globalissues.org/issue/169/biodiversity

The Encyclopedia of Earth: Biodiversity – www.eoearth.org/topics/view/49480/

IUCN: Biodiversity – <http://iucn.org/what/tpas/biodiversity/>

TUNZA – <http://www.ourplanet.com/tunza/>

Urban Times: I Want YOU for Science – <http://www.theurbn.com/2012/05/i-want-you-for-science/>

Websites for Kids

EPA Students – <http://www.epa.gov/students/index.html>

Biodiversity: Everything Counts! – www.amnh.org/ology/?channel=biodiversity

Biodiversity, Food and Farming for a Healthy Planet – www.cbd.int/ibd/2008/youth

Biological Diversity for Kids – <http://kids.cbd.int/>

Defenders of Wildlife/Kids' Planet – www.kidsplanet.org/

Little MAB - www.biosphere-vosges-pfaelzerwald.org/_uk/html/frameset/frameset_ptit_mab.htm

Nature Detectives – www.naturedetectives.org.uk/

UNEP and Tunza for Children – www.unep.org/tunza/children/

Natural History Museum “Kids Only” – www.nhm.ac.uk/kids-only/index.html

ESA Kids Earth Gorilla Watch – http://www.esa.int/esaKIDSen/SEMJXKXJD1E_Earth_0.html

Websites: Teaching Resources

Teaching Resource Kit for Mountain Countries – http://www.unesco.org/new/en/natural-sciences/about-us/single-view/news/educational_resource_kit_for_mountainous_regions/

Teaching Resource Kit for Dryland Countries – <http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/specific-ecosystems/drylands-desertification/publications-drylands-desertification/teaching-resource-kit/>

Education Kit on Combating Desertification – <http://www.unesco.org/new/en/natural-sciences/environment/ecological-sciences/specific-ecosystems/drylands-desertification/publications-drylands-desertification/learning-to-combat-desertification/>

Connecting Children with Nature Action Forum – www.worldforumfoundation.org/wf/wf2010_nature/index.php

Global Oneness Project Study Guide – www.globalonenessproject.org/education

Environmental Action Kit – <http://worldforumfoundation.org/wf/wp/initiatives/nature-action-collaborative-for-children/environmental-action-kit/>

C&NN Natural Teachers Network – <http://childrenandnature.ning.com/group/naturalteachers>

Creating the Web of Life – www.pz.harvard.edu/ucp/curriculum/ecosystems/s1_res_weboflife.htm

Diversity of Life – www.nclark.net/Diversity

Tree World – www.domtar.com/arbre/English/index.asp

Module on biodiversity and agriculture – www.cbd.int/ibd/2008/Resources/teachers.shtml.

“The Green Wave” campaign – <http://greenwave.cbd.int/educators>

Convention on Biological Diversity for Educators – www.cbd.int/youth/resources/educators.shtml

The Environment Protection and Biodiversity Conservation Act 1999: See www.environment.gov.au/about/publications/index.html or: www.environment.gov.au

Wildlife Conservation – www.classroomearth.org/wildlife

100 Resources for teaching your kids about Wildlife Conservation – www.ecologyproject.org/about/news/924/100_resources_for_teaching_your_kids_about_wildlife_conservation/

The Green Pack Environmental Components: Biodiversity – http://greenpack.rec.org/flash_wheel/index.html?0

BBC Class Clips “Living Things in their Environments: Conservation” – www.bbc.co.uk/learningzone/clips

Kew “The Great Plant Hunt” – www.greatplanthunt.org/

Natural History Museum “Education” – www.nhm.ac.uk/education/index.html

Websites: Tools and Resources

UNESCO Beijing List of Cooperative Projects – <http://www.unescobej.org/lists/links/cooperative-scientific-and-small-scale-projects/>

UNESCO Beijing EABRN – <http://www.unescobej.org/natural-sciences/environment/ecological-and-earth-sciences/east-asian-biosphere-reserve-network-eabrn/>

Eden Project UK – <http://www.edenproject.com/whats-it-all-about>

My Community, Our Earth – <http://www.aag.org/cs/mycoe/participate>

Biodiversity: Things we can do on a daily basis –

www.educapoles.org/index.php?s=no&puid=635&uid=551&lg=en

Biodiversity Educational Resources –

www.biodiversity911.org/EducationalResources/EducationalResources.html

Biofotoquiz – www.biofotoquiz.ch/biofotoquiz/index.php?langCode=E

David Suzuki's Nature Challenge – www.davidsuzuki.org/NatureChallenge/

Toolkit for Coordinators of National Biodiversity Strategies and Action Plans (NBSAPs) –

www.cepatoolkit.org/

IUCN Red List of Threatened Species: Amazing Species – www.iucnredlist.org/amazing-species

LEAF Forests, Climate and Biodiversity – www.leaf-international.org/Side.cfm?ID_kanal=5

Bristol Natural History Consortium “BioBlitz” – www.bnhc.org.uk/home/bioblitz/

Meet Your Neighbours – meetyourneighbours.net/

Natural History Museum – www.nhm.ac.uk/

Arkive Images of Life on Earth – www.arkive.org/

FAO Biodiversity Initiative – <http://www.fao.org/climatechange/youth/60638/en/>

CBD Biodiversity Multimedia Resources – <http://www.cbd.int/2010/multimedia/>

University of Cambridge MPhil in Conservation Leadership –

<http://www.geog.cam.ac.uk/graduate/mphil/conservation/>

UNESCO Montevideo Natural and Cultural Tourism (In Spanish) –

<http://www.unesco.org.uy/cultura/es/areas-de-trabajo/cultura/proyectos-destacados/rbbe.html>

UNESCO Teaching and Learning for a Sustainable Future Resource Kit –

<http://www.unesco.org/education/tlsf/>

National Biodiversity Strategy And Action Plan In Syria –

<http://www.4enveng.com/edetails.php?id=39>

Biofotoquiz – <http://www.biofotoquiz.ch/biofotoquiz/index.php>

Websites: Articles

“Brasilia UNESCO Associated Schools discuss education and biodiversity in Manaus” –

http://portal.unesco.org/geography/en/ev.php-URL_ID=13517&URL_DO=DO_PRINTPAGE&URL_SECTION=201.html

WWF Living Planet Report 2008 – assets.panda.org/downloads/living_planet_report_2008.pdf

Sustaining Life on Earth - www.cbd.int/iyb/doc/prints/cbd-sustain-en.pdf

UNEP TUNZA Magazine for Youth on Biodiversity -

www.ourplanet.com/tunza/issue0303en/pdfs/complete.pdf

AUB IBSAR Nature Conservation Center for Sustainable Features Annual Report 2011 – www.aub.edu.lb/units/ibsar/library/publications/Documents/ibsar_annual_report.pdf

Bush Telegraph: Biodiversity – http://portal.unesco.org/en/ev.php-URL_ID=47841&URL_DO=DO_TOPIC&URL_SECTION=201.html

South-South Cooperation Biodiversity Newsletter – <http://www.cbd.int/cooperation/ssc/ssc-newsletter-01-01-en.pdf>

Inside National Geographic “Great Migrations” – http://ngm.nationalgeographic.com/gombe-hub?source=email_inside

THE “ESA maps satellite help for gorilla guardians” – <http://www.timeshighereducation.co.uk/story.asp?storyCode=174799§ioncode=26>

ESA “Gorilla Habitats” – http://www.esa.int/esaEO/SEM0GE3VQUD_environment_0.html

UNESCO Beijing “Building Ecologically Harmonious Civilization” – <http://unesdoc.unesco.org/images/0018/001880/188020M.pdf>

Videos: Documentaries

The 2010 Biodiversity Target – www.cbd.int/doc/videos/cop-08/2010-target.swf

“Love Not Loss” Biodiversity Video – www.youtube.com/watch?v=BvIdwOEzreM

Biodiversity Video Gallery - www.cbd.int/videos/

UNESCO Kids Animal Preservation Video – <http://whc.unesco.org/uploads/activities/documents/activity-50-10.wmv>

Videos: Short Clips and photos

The 2010 Biodiversity Target – www.cbd.int/doc/videos/cop-08/2010-target.swf

“Love Not Loss” Biodiversity Video – www.youtube.com/watch?v=BvIdwOEzreM

Biodiversity Video Gallery - www.cbd.int/videos/

UNESCO Kids Animal Preservation Video – <http://whc.unesco.org/uploads/activities/documents/activity-50-10.wmv>

Organizations

Global Footprint Network – www.footprintnetwork.org/en

World Wildlife Foundation – www.wwf.org

National Geographic – www.nationalgeographic.org

Smart Communities Network – www.smartcommunities.ncat.org/overview/ovedtoc.shtml

World Bank Development Education Program – www.worldbank.org/depweb/

Tunza for Children – www.unep.org/tunza/children/

Convention on Biological Diversity – www.cbd.int/

Association for the Protection on Jabal Moussa – www.jabalmoussa.org/

Namib Desert Environmental Education Trust – www.nadeet.org/

SADC Regional Environmental Education Programme – www.sadc-reep.org.za/

Biodiversity Education and Awareness Network – <http://biodiversityeducation.ca/>

Greenpeace International – www.greenpeace.org/international/en/

IRDNC – www.irdnc.org.na/

Children in Nature Collaborative – www.cincbayarea.org/who.htm

CEE India Biodiversity – www.ceeindia.org/cee/biodiversity_consrvtn.html

Volvo Adventure – www.volvoadventure.org

Eco Schools – www.keepbritaintidy.org/ecoschools/aboutecoschools

Ecological Handprints – www.ecologicalhandprints.org/

MIO for Environment, Culture & Sustainable Development – <http://www.mio-ecsde.org/>

Makhzoumi Foundation – <http://www.mio-ecsde.org/>

Annex – Template for Case Studies

Reading Level: Lower or mid secondary school

General Description

Title	<i>(10 words)</i>
Abstract	<i>(50-100 words for the teacher's manual)</i>
Description of the Specific Challenge in this Case Study	<i>(150-200 words) Describe the specific challenge on the processes, policies, practices, etc. that cause the challenge. This section could also be a positive example of how a challenge has been met.</i>
Illustration photographs & Illustration web link (High Resolution only, at least 300 dpi)	

Description of the perspectives

1.	<p>Historical Perspective <i>(100-200 words including a timeline)</i></p> <p>Describe the timescale of the challenge as well as the time frame of the institutional aspects linked to the challenge.</p>	
References and Web links (URLs)		
2.	<p>Scientific Perspective <i>(150-200 words)</i></p> <p>Describe the challenge based on the collection, analysis and interpretation of empirical data across biotic and abiotic components of Earth.</p>	

References and Web links (URLs)		
3.	<p>Geographic Perspective (100-150 words including a small map)</p> <p>Describe the geographic distribution of the challenge as well as its connections to the global outlook.</p>	
References and Web links (URLs)		
4.	<p>Gender Perspective (150-200 words)</p> <p>Describe the way the challenge affects men and women, boys and girls.</p>	
References and Web links (URLs)		
5.	<p>Cultural Diversity Perspective (150-200 words)</p> <p>Describe the way the challenge affects different people (indigenous people, minorities, dominant culture...)</p>	
References and Web links (URLs)		
6.	<p>Human Rights Perspective (150-200 words)</p> <p>Describe how the challenge infringes on the human rights of any group of people.</p>	
References and Web links (URLs)		
7.	<p>Sustainability Perspective (100-150 words)</p> <p>Describe the balance between environmental, social and economic concerns in the challenge</p>	

References and Web links (URLs)		
8.	Values Perspective <i>(100-200 words)</i> Describe the values involved in creating and solving the challenge.	
References and Web links (URLs)		

Conclusion of the Case Study

Potential Actions and Solutions <i>(50-150 words)</i>	<p><i>At what levels should action occur to ameliorate challenge? (E.g., national government, civil society)</i></p> <p><i>What actions could be suggested to empower individuals to address this challenge?</i></p>
Concluding Remarks <i>(50-100 words)</i> Statement that acknowledges the gravity and complexity of the challenge as well as instilling hope.	
Engaging Questions 3 – 5 higher-order thinking skill questions about this case study that the students can answer without much additional research	<p><i>(e.g., does a similar challenge exist in your community? Within your cultural context what would be a good solution? Would the outcome of one of the proposed actions be? Would the action benefit one group of people, but not to another?)</i></p>

Thank you for sharing your case study.

UNESCO has launched the “*ESD Learning & Training Tools*” series to enhance the availability of teaching, training, learning and resource materials on Education for Sustainable Development (ESD) issues through a wide set of practical tools. In particular, this series provides individuals, communities and governments that are at different stages in their understanding of the benefits of a sustainability approach and the role of education in it, with practical tools to review their situations and put in place ESD actions.

UNESCO has prepared *Learning about Biodiversity - Multiple-Perspective Approaches* as a thematic companion to *Exploring Sustainable Development: A Multiple-Perspective Approach* to focus on applying multiple perspectives for ESD to biodiversity issues. It contains lesson plans, questions, lists of teaching resources including online videos, and case studies. Students are guided to understanding through eight unique, but overlapping, perspectives (scientific, historical, geographic, human rights, gender equality, values, cultural diversity, sustainability) on the relationships within natural systems and between natural systems and human society.

