ACRF
ARM Climate Research Facility

Climate Education Update

News and information about climate change studies for teachers and students

January 2005

The Basics of Biodiversity

by Paul M. Rich

"Biological diversity is the key to the maintenance of the world as we know it."
- Edward O. Wilson

Scientists estimate that we share the world with 30 to 100 million distinct types of living organisms, known as species, and that only about 1.6 million of these species have been named and described. Biological diversity, or biodiversity, is vital for our well being, from both economic and aesthetic perspectives. A recent Internet search for the word "biodiversity" revealed 3,460,000 sources, with websites ranging from scientific treatments about "endemism in Papua New Guinea," discussing species that only occur in the islands of Papua New Guinea, to information about the citizen action group Alaska Center for the Environment (ACE), dedicated to responsible stewardship of Alaska's natural environment. The large number of websites addressing biodiversity reflects both a human fascination for the myriad of organisms on our planet and a concern for the protection of our natural heritage.

"Biological diversity, or biodiversity is vital for our well being, from both economic and aesthetic perspectives."

Our fascination with biodiversity is deeply rooted. We are filled with excitement and awe at the sighting of a caribou in the tundra of the Arctic National Wildlife Refuge in Alaska, a clown anemonefish in a coral reef of Nauru Island in the South Pacific, a tall fig tree in the rainforest of Papua New Guinea, or a small insect-eating rainbow plant in the coastal plains of Papua New Guinea and Australia. Questions of all sorts arise. What is this living organism? What is it doing? How does it fit into a bigger picture of our world? Teaching about biodiversity can be fun, as well as serve as a vehicle to understand fundamental scientific principles and to develop strong problem solving skills. Let's start with some basics.

What is biodiversity?

The American Heritage Dictionary defines biodiversity as: *1. The number and variety of organisms found within a specified geographic region. 2. The variability among living organisms on the earth, including the variability within and between species and ecosystems.*

The term "biodiversity" is actually a relatively new word. In 1980, biologist Thomas Lovejoy coined the term "biological diversity," and biologist Edward O. Wilson and his colleagues contracted it to "biodiversity" in 1986. Biodiversity refers to variety in living organisms. This variety occurs at many different levels.

One level of biodiversity is ***species richness***, the number of different species in a given area. The species richness in tropical regions is typically much higher than that of temperate regions. Papua New Guinea, located in tropical latitudes, has exceptionally high species richness, about 5% of the worldwide biodiversity, with over 300 species of corals, over 700 species of birds, about 20,000 species of ferns

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and flowering plants, and an estimated 300,000 species of insects.

By contrast, Alaska, with a total area more than three times larger than Papua New Guinea, has much lower species richness in most groups, low even relative to the continental United States. However, Alaska, with its extensive land area that is relatively undisturbed by humans, is rich in species and ecological processes that are now rare or gone from other parts of the world, including large migratory caribou herds, abundant salmon in the rivers, and healthy populations of large predators such as bears and wolves.

Another level of biodiversity is ***genetic heterogeneity***, variation within a species that has a genetic or heritable basis. Wild species harbor much greater levels of genetic heterogeneity than domesticated species. For example, domestic potatoes are typically all one variety (a monoculture) with very low genetic diversity. This proved to be a major problem for Ireland in the 1800s. Four similar varieties of potatoes were introduced to Ireland from South America in the early 1600s, all with low genetic resistance to potato fungus diseases. By 1800, potatoes had become the major food source for poor people in Ireland. The crops became infected with the potato blight fungus, and the crops failed almost completely in 1845, 1846 and 1848.

Over one million peasants in the country died from starvation; people streamed into towns and cities where about another million died from cholera and typus diseases in the overcrowded conditions; and another two million people left Ireland to find new opportunities in the European mainland and North America.

Why did this happen? The potatoes came from Peru, where a farmer in the Andes may sow more than 100 varieties in his fields, producing tubers that are fat, skinny, lumpy, or smooth; long, short, round or square; purble, blue, red, yellow, green, or white; and with surprisingly different flavors. Literally thousands of varieties have been recognized, and some of these varieties are quite resistant to fungal diseases. The International Potato Center in Lima Peru maintains a gene bank of about 3,800 varieties of potatoes that are available to reintroduce genetic variability to commercially grown potatoes.

Why should we care about biodiversity?

The reasons to care about biodiversity are many. From a utilitarian perspective, the organisms of our planet produce **economic goods**, literally providing many of the key natural resources on which human existence and modern civilization depends. Economic goods from the plants, animals, and microbes of our planet include food, fuel, fiber, building materials, and medicine. All of the food we eat comes from other living organisms, whether domesticated in the form of rice, wheat, soybeans, and hundreds of crops, or wild in the form of forage, fruits, nuts, fish, and wild game. Even the fossil fuels (oil, gas and coal) represent past biodiversity, in that they were formed from the fossilized remains of now long-dead plants and animals.

Most of the medicines we use were originally isolated from wild plants, and many are then synthesized from petroleum byproducts. Much of human recreation and tourism depends upon biodiversity, whether it involves direct use, such as for hunting and fishing, or indirect enjoyment, such as photography, nature walks, and bird watching. Biodiversity also represents **natural capital**, which refers to the wealth and economic importance of raw materials. Examples of natural capital are soils, flora, fauna, and minerals.

From a utilitarian perspective, we are also dependent on other living organisms for **ecological services**, a broad set of useful functions which benefits our human economy. Ecological services include flood control, water purification, waste decomposition, absorption and detoxification of pollutants, pollination of crops, soil formation, and moderation of weather. We can appreciate the value of these ecological services when we lose them. For example, after a bushfire or wildfire there are often problems of flooding and soil loss until plants become re-established, highlighting the value of well-vegetated watersheds for moderating water flow.

Another example resulted when cattle were introduced to Australia without the dung beetles. These beetles bury the cow dung and play a very important role in decomposition. Introduction of dung beetles averted an environmental crisis in which the Australian continent was literally being covered by cow dung.

Biodiversity has many non-utilitarian values, including **aesthetic** and **cultural values**. The plants, animals, and microbes of the planet are beautiful to us and vital to the continuance of many of our cultural practices. Many would argue that other living organisms also have **intrinsic value**, or a basic right to exist. We can easily take it for granted that we believe that humans have intrinsic rights, such as the right to happiness and freedom. Aldo Leopold, a great environmental scientist and writer, proposed the concept of a "land ethic" that expands the concept of intrinsic rights not only for humans, but also for "soils, waters, plants, and animals, or collectively, the land."

Responsible use of the land and biodiversity it contains is termed "stewardship." This stewardship can also be thought of in terms of the **legacy value**, the value for future generations. ■

Bio - What?!
Helping students understand biodiveristy

Bio-What?! What is biodiversity? In a recent study, only two out of 10 adults reported having heard about or knowing about "the loss of biological diversity." Yet the accelerating loss of biodiversity is probably the most serious environmental threat facing the planet right now. In this activity, students learn about biodiversity and find out that our very survivial as a species depends on its preservation.

1. Ask students: *What does the word "biodiversity" mean?*

Break this word into two parts for the students: "*bio*" means "*life*" and "*diversity*" is a synonym for "*variety*." Therefore, biodiversity means "the variety of living plants and animals in the world."

2. Ask students: *How many species of plants and animals do you think there are in the world?*

Actually, nobody knows. When it comes to biodiversity, scientists have far more questions than they have answers! Over 200 years ago, the biologist Linnaeus told us that there were exactly 4,236 species. Since then, biologists and other scientists have named and described approximately 1.6 million species, although we know very little about most of these species. Estimates of the total number of species of plants and animals range from 30 to 100 million. Over three-quarters of this number is probably made up of members of the insect family.

3. Read the following sentence aloud to your students:

"If humans don't have any use for a plant or animal, then it might as well not exist in the first place."

Responding to this statement will give students an opportunity to examine their own values, and to realize that not all their peers share those values! Ask your students if they agree or disagree with this statement and to state why.

4. Discuss how the following human activities may threaten biodiversity:

Water pollution (chemicals and garbage in oceans, streams, rivers and lakes) Air pollution (greenhouse emissions which may lead to melting ice, rising sea levels, drought, or flood due to global warming) Deforestation (cutting trees in forests for timber to construct buildings and homes)

5. Inform students:

Using the Teacher's Notes on page four, discuss the six main reasons why biodiversity should be preserved. The Teacher's Notes also contain discussion questions for each of the six reasons for preserving biodiversity - encourage students to answer each thought-provoking question. Make lists of the answers on the board. Plan an activity for the students to share their knowedge, perhaps by making a poster for the school, another classroom or the local library.

Do you have an article idea for the next issue of this newsletter?
Do you have a lesson you would like to share with other teachers?

Tell us about it!

The ACRF Education and Outreach team would appreciate your ideas and feedback about the Climate Education Update Newsletter.

If you have article ideas, classroom stories, or messages from students, please contact us. You can write us a letter, send an e-mail message, call us on the telephone, or send a fax!

Mailing address
ACRF Education and Outreach
Los Alamos National Laboratory
PO Box 1663, MS J577
Los Alamos, NM 87545 USA

Email address
armeducation@lanl.gov

Telephone 1-505-667-1186 **Fax** 1-505-667-9122

Teacher's Notes

Biodiversity belongs.

The plants and animals with whom we share this planet have a right to exist - whether or not they are useful to humans.

Do you think it is fair for humans to make another species go extinct?

Biodiversity helps us heal ourselves.

Over a hundred different species of plants are known to provide medicine for humans. Forty percent of the medicines found in pharmacies are derived from plants. For example, without Rosy Periwinkle, many more children would die from childhood leukemia.

Do you think it is possible the cures for cancer, malaria or the common cold lie in a local plant? Do you know of a local plant that is used to keep people healthy?

Biodiversity keeps natural areas together...

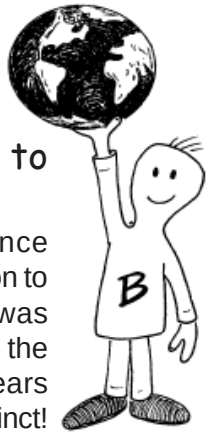
...and natural areas (ecosystems) provide us with essential services like clean air and fresh water. Every time we lose a species from an ecosystem, we change the way the whole system works. If this continues, the area loses its ability to provide us with ecosystem services.

Do you know of an endangered species in your region?

Biodiversity attracts tourists.

Tourism is the most rapidly growing industry in the world; and ecotourism (which helps people enjoy nauture and ecosystems) is the most rapidly growing kind of tourism! All kinds of places - from Papua New Guinea to Costa Rica - need to preserve biodiversity to keep their economy strong.

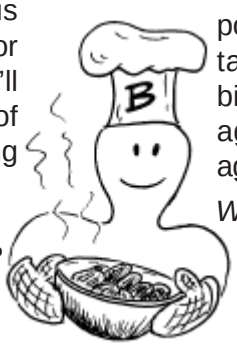
What attracts tourists to the place where you live?



Biodiversity gives us food.

Twenty species of plants (wheat, rice, corn, potatoes, barley, etc.) give us 80% of the food we eat. If disease or insect pests attack these crops, we'll need the more resistant varieties of these plans that are currently growing wild.

What natural foods do you harvest?



Biodiversity helps life to continue on earth.

Being diverse is life's insurance policy. Biodiversity helps evolution to take place. For example, it was biodiversity that helped usher in the age of mammals 65 million years ago, when the dinosaurs went extinct!

What can you do to preserve biodiversity?

This lesson is courtesy of Canadian Parks and Wilderness Canadian Parks and Wilderness Society, Calgary Banff Chapter and can be accessed on the Internet at www.geoec.org/lessons/

Teaching about Biodiversity by Paul M. Rich

We can learn a lot from books or experts, but nothing substitutes for learning directly from the other living organisms on our planet. Study of biodiversity means getting out in nature and learning first hand. Let's explore a learning activity called "niche hunting" to encourage creative exploration of local biodiversity.

A ***niche*** is the ecological role of a species in the community, as defined by the conditions and resource qualities within which the organism persists. An organism's niche is distinct from ***habitat***, the actual physical place where an animal or plant normally lives. Think of habitat as the home and niche as the occupation. Niche hunting involves three steps. First students choose a plant or animal to observe. Next, each student spends time observing the organism, say 10-15 minutes for younger students and half an hour or more for older students. Finally, students get together in pairs and try to guess what organism their partner was observing.

The idea is to see how well students can describe the chosen organism's niche, in terms of where it lives, what it does, how it relates to other organisms and how it differs from other organisms. This exercise is in the tradition of natural history, which involves careful observation and detailed description. It can be done anywhere, ideally in a place where students can safely spread out and choose from a variety of different plants or animals. It is always best for the teacher to do investigating beforehand, preparing a list of possible organisms to observe, checking for hazards (e.g., poisonous plants or unsafe conditions) and determining some basic principles to emphasize.

Use the following activity guide to lead students on a niche hunting adventure!

Niche Hunting Activity Guide

Step One: Introduce the term "niche" to the students. Explain that a niche is the role an organism plays in the environment in which it lives. Students should understand that each organism has a special niche, which can be defined by what the organism does, where it lives, what it eats, etc.

Step Two: Tell the students that their assignment is to go "niche hunting." Explain that niche hunting requries careful observation. Help students choose a plant or animal to observe. The organism should exist in the environment right outside the classroom. Students can also choose from a list that you create.

Step Three: Ask students to make an observation chart to record their findings. Provide four questions to help guide the students' observations. Explain to students that they should take detailed notes about the organism they have chosen to observe because at the end of the project, a fellow classmate will guess the name of the organism that was observed. An example student observation chart is provided below.

Step Four: Allow the students to go outside and make observations. Encourage students to be quiet and respectful of the habitat in which the organisms exist.

Step Five: Bring the students back into the classroom and allow them time to complete their observation charts. Then ask students to pair up and exchange observation charts with a fellow classmate. The students should read each other's observations, engage in a discussion, and ask questions. Finally, guesses can be made about what organisms were observed.

Step Six: Conclude the activity by facilitating a class discussion. Ask one or two students to share their observations with the class. Then ask all the students to write down which items on their charts are actually required by the organism for it to survive

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Student Observation Chart

Name	Date of observation
1. Where do I live? Example: In deep shade in forest; at low elevations; prefer lots of big trees; don't like hot bright sun; like shrubs sometimes; close to stream	2. What do I do? Hunt at night; sleep in the day; live in trees; never seen on ground; have one baby a year; make weird sounds at night; baby carried in a pouch; drink water
3. How do I relate to other plants or animals? Eat lots of leaves; run away from people; eat insects; sometimes people eat me	4. How am I different from other animals? Have brown fur; have long tail that helps me to balance; have big eyes so I can see at night; live alone (not in a group); have pouch for baby
Student interpreter's name:	Guess: *(correct answer is tree kangaroo)*

as a baby, grow up to be a healthy adult, and live long enough to have its own babies. Students do not have to rely solely on the information they have recorded on their observation charts; they can also use facts they know or have researched about the organism. Students should share their answers with the class.

This list of requirements is the start of defining the organism's niche. The following items are required by a tree kangaroo for survival from birth to adulthood: must have mature forests of big trees in a cool, moist environment with the correct type of trees and bushes with leaves to eat; must have protection from being killed (i.e. mother's pouch); needs enough forest land so that it can live alone and still find a mate in a neighboring forest area.

As students share and discuss their observation charts and make guesses about what organisms were observed, they can come up with some general principles about biodiversity and niches. The following are some examples: 1. The niche is unique to each species 2. The niche can be described only by careful study 3. The niche includes physical things like how much space; how high above the ground; how steep or flat the ground can be 4. The niche includes other living things such as plants and animals 5. The niche includes climatic things like temperature, sunlight, winds, how much it rains and how often 6. The niche includes social things like how much interaction this organism needs with others of the same species.

The possibilities to teach biodiversity are only limited by the imagination! An increasing number of high-quality online resources are available for teaching about biodiversity. Visit the following web sites for more information:

EcoEdNet, Ecological Society of America: http://www.ecoed.net

Center for Biodiversity and Conservation, American Museum: http://research.amnh.org/biodiversity

The Virtual Library of Ecology and Biodiversity: http://conbio.net/vl

Biodiversity and Biological Collection Webserver: http://biodiversity.uno.edu

Nature Serve: http://www.natureserve.org

ACRF Education and Outreach
Mail Stop J577
Los Alamos National Laboratory
Los Alamos, New Mexico 87545
505/667-1186 (phone)
ARMEducation@lanl.gov

LALP-03-043

ACRF Education and Outreach Director:
Larry Jones
Editing and Layout:
Andrea Maestas