Teaching Biodiversity to Students in Inner City & Under-Resourced Schools

Authors: McCoy, Michael W., McCoy, Krista A., and Levey, Douglas J.

Source: The American Biology Teacher, 69(8) : 473-476

Published By: National Association of Biology Teachers

URL: https://doi.org/10.1662/0002-7685(2007)69[473:TBTSII]2.0.CO;2

Teaching Biodiversity
to Students in Inner City & Under-Resourced Schools

ARTICLE

MICHAEL W. MCCOY KRISTA A. MCCOY DOUGLAS J. LEVEY

The natural world is very different today than it was 10,000 or even 1,000 years ago. Every natural ecosystem on the globe has been altered, many severely, as a consequence of rapid increases in human population size and the expansion of human habitation (Myer & Simon, 1994; Kareiva & Marvier, 2003). However the problem is not just a consequence of the number of people on the earth; it is also where and how we live (Myer & Kent, 2004). The critical consequence is a loss in the diversity of life – "biodiversity" and all of the services it provides. Alarmingly, species loss is thought to be between 10 and 30 thousand species per year (Meffe & Carroll, 1997; Kareiva & Marvier, 2003; Leakey, 1996). At that rate, much of the earth's biodiversity will be lost in the next century – even before many of the lost species are discovered (Leakey, 1996; Kareiva & Marvier, 2003). Indeed, the rate at which species are being lost today actually exceeds the rate of extinctions that occurred following the meteor impact that led to the extinction of dinosaurs (Leakey, 1996).

Why should we care about conserving biodiversity? First, humans have an emotional affiliation and innate tendency to focus on novelty and diversity. E.O. Wilson (1984) termed this attraction "biophilia" and argued that our natural affinity to living things is the basis of our humanity. Second, the loss of species represents a significant loss of information. In particular, the extinction of unstudied species has been described as being equivalent to setting fire to a vast library of medical texts, agricultural guides, construction manuals and art collections that no one has ever read or studied (Meffe & Carroll, 1997). Lastly, species provide irreplaceable goods and services (Myer, 1996; Balmford et al., 2002). We extract food, fuel, building supplies, medicines, and ideas (e.g., airplane wing shape) from the natural world. In addition, we receive important services such as pollination, clean air, fresh water, fertile soil and a benign climate (Myer, 1996; Costanza et al., 1997; Karieva & Marvier, 2003).

The value of biodiversity is not obvious to many people. This is especially true for students who lack real life experience with nature. Their under-appreciation of biodiversity is problematic because efforts to conserve biodiversity require broad public support. Therefore it is important to have an informed and scientifically literate populous with a conceptual understanding of why biodiversity is valuable, both economically and ethically. The importance of biodiversity education is highlighted by the strong component of "biodiversity" related concepts in the *National Science Education Standards* (NSES).

In response to this need and as part of a National Science Foundation GK-12 program (Science Partners in Inquiry-Based Collaborative Education; SPICE) we have developed a classroom activity to introduce students to the intrinsic and economic values of biodiversity. This activity simultaneously helps students discover their innate affinity for biodiversity and reinforces the NSES recommendations. (See Table 1 for a summary of the standards addressed by this activity)

Importantly, biodiversity and associated concepts are often considered teachable only in the realm of field trips (Zervanos & McLaughlin, 2003; O'Neal & Skelton, 1994; Beiersdorfer & Davis, 1994). However, access to wild areas or natural history museums are often limited for students and teachers in inner city and under-resourced schools. Therefore, we introduce the concept of diversity in general and biodiversity in particular using in-classroom activities and a media presentation. The goals of the lesson are to influence students' attitudes about biodiversity in a positive way and to encourage their further study of it.

To stimulate a positive attitude about biodiversity, students are led to recognize that they have an intuitive understanding of and affinity for diversity. This recognition is then used to stimulate their exploration of the intrinsic and utilitarian value of biodiversity. Finally, by stimulating a positive attitude and providing knowledge about biodiversity and the consequences of its loss, students develop an appreciation for why scientists are concerned about the extinction of species. We hope they will become concerned, too.

The Activity

We use an interactive PowerPoint presentation to illustrate to students that they have an innate affinity for biodiversity, introduce the concept of biodiversity, and discuss the products and services that we get from nature. To download this presentation or associated activities, visit http://www.spice.centers.ufl.edu/modules.asp or contact the authors. Finally, we discuss the causes of biodiversity loss and steps that can be taken to help conserve it. The presentation is divided into seven parts.

Part 1

Show pairs of images (Figure 1) to the students for 10 seconds and ask them to write down which image from each pair they prefer. If they ask what you mean by "prefer," tell them that it's up to them to decide for themselves; the less information you provide at this point, the better. Next ask each student to provide one reason why he/she picked a

MICHAEL W. MCCOY (mmccoy@zoo.ufl.edu) is a Postdoctoral Associate, and KRISTA A. MCCOY (kristam@zoo.ufl.edu) is a Ph.D. candidate, both in the Department of Zoology, University of Florida, Gainesville, FL 32611-8525. DOUGLAS J. LEVEY is Professor, Department of Zoology, University of Florida, Gainesville, FL 32611-8525; e-mail: dlevey@zoo.ufl.edu.

Table 1. Summary of National Science Education Standards addressed by this activity.

STANDARD	DESCRIPTION	MATCHING COMPONENT FROM THIS ACTIVITY
Life Science Concepts		
Structure and Function	Complementary nature of structure and function at levels from the cell to the ecosystem	Students discuss the components of diversity from genes to ecosystems.
Populations and Ecosystems	Functions of specific species within ecosystems, including the parts they play in the transfer of energy among organisms through food webs.	The roles of organisms in their ecosystem are highlighted as a discussion about ecosystem services.
Diversity and Adaptations	Interaction between the diversity of organisms and biological adaptation to specific circumstances, including the role played by evolution and the phenomenon of extinction.	This lesson covers the concept of diversity in general and emphasizes the phenomenon of extinction.
Unifying Concepts and Processes		
Systems, Order, and Organization	Understanding of the universe as a composite of many parts.	Students discuss the components of diversity from genes to ecosystems. Students also learn the cascading consequences of species loss.
Science in Personal and Social Perspectives		
Populations, Resources and Environment	Negative impact of overpopulation on the environment and to the various causes of environmental degradation.	Students learn about the tension between human population growth, development and consequences of biodiversity loss.

particular image. Beginning the activity in this way engages the students because they are unsure what answers you are expecting and they are curious as to why they are doing the activity.

Part 2

Have the students put their answers from Part 1 aside for a moment. Next, using illustrations (Figure 2) discuss the meaning of biodiversity (multiple types of living organisms) and that it has different components. For example, **genetic diversity** may be illustrated using different breeds of dogs. All the dogs pictured are the same species (can breed with one another) but they are genetically distinct. **Species diversity** may be illustrated by showing three distinctly unique animals (e.g., a slug, squirrel, and tree frog). Lastly, **ecosystem diversity** can be illustrated with images of different types of easily recognizable ecosystems (e.g., a coastal habitat, rainforest, beaver pond or wetland) (Figure 2).

Part 3

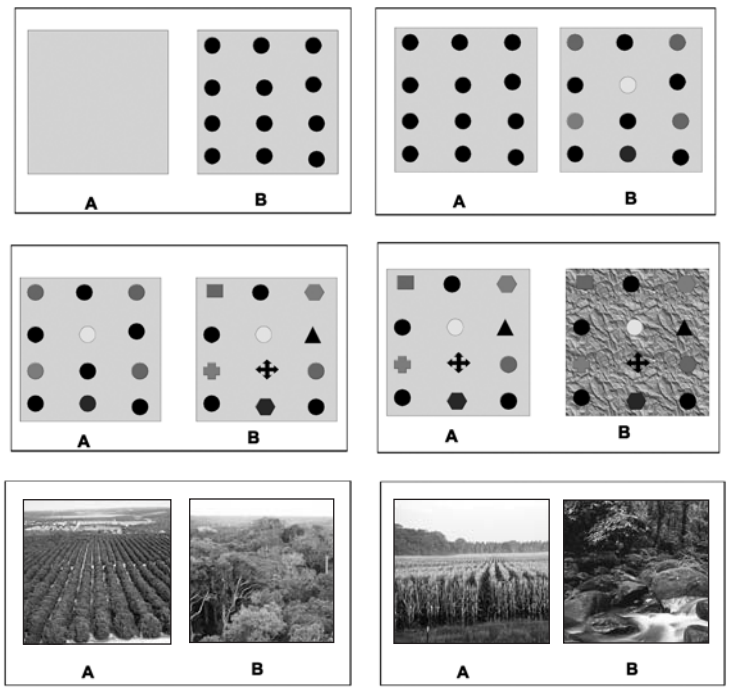
Show the students the same series of images as in Part 1, except this time ask them to record which image illustrates higher diversity (Figure 1). This exercise has a dual function. It allows one to assess students' understanding of the concept of diversity and it provides a springboard into discussion about the value of biodiversity.

Part 4

Have students count the number of times that the image they preferred during Part 1 was also the image illustrating higher diversity in Part 3. Ask how many originally preferred the images that were also the most diverse. Most students prefer the more diverse pictures. Why? This provides an opportunity to discuss two of the core postulates of modern conservation biology: 1) "Diversity is good," and 2) "Biotic diversity has intrinsic value" (Meffe & Carroll, 1997). To highlight the first postulate, "Diversity is good," ask the students if they would like it if everyone dressed identically and had the same hair cut. Or, what if there was only one music group? What if all buildings/houses looked the same? Lead a discussion about whether the students think their answers support the idea that humans are inherently attracted to diversity. To highlight the second postulate, "Biotic diversity has intrinsic value," extend the discussion to an evaluation of species

Figure 1. Which Do You Like Better?

Example of abstract and real images that can be used to illustrate and explain diversity and its intrinsic value. For each panel in the figure, students are asked to pick which picture ("A" or "B") they most prefer, and then which is the most diverse. In both the abstract and real examples, most students exhibit a preference for the most diverse image. Rainforest photos (image B in both lower panels) were taken from NASA-sponsored Web sites: http://www.nasa.gov/vision/earth/environment/0624_hanpp.h and http://earthobservatory.nasa.gov/Laboratory/Biome/biorainforest.html. Orange and corn photos were taken from USDA-sponsored Web site: http://www.usda.gov/oc/photo/opclibra.htm.



diversity and whether natural diversity is good for our well-being and for the well-being of nature (i.e., other organisms and ecosystems). For example, what if there were no insects to pollinate flowers or no plants to provide oxygen? This discussion will highlight that conserving biodiversity is a matter of ethics (i.e., is good for the well-being of humankind) as well as aesthetics, and that we have an innate preference for diversity. This can be a springboard for discussing the importance of cultural diversity as well.

Part 5

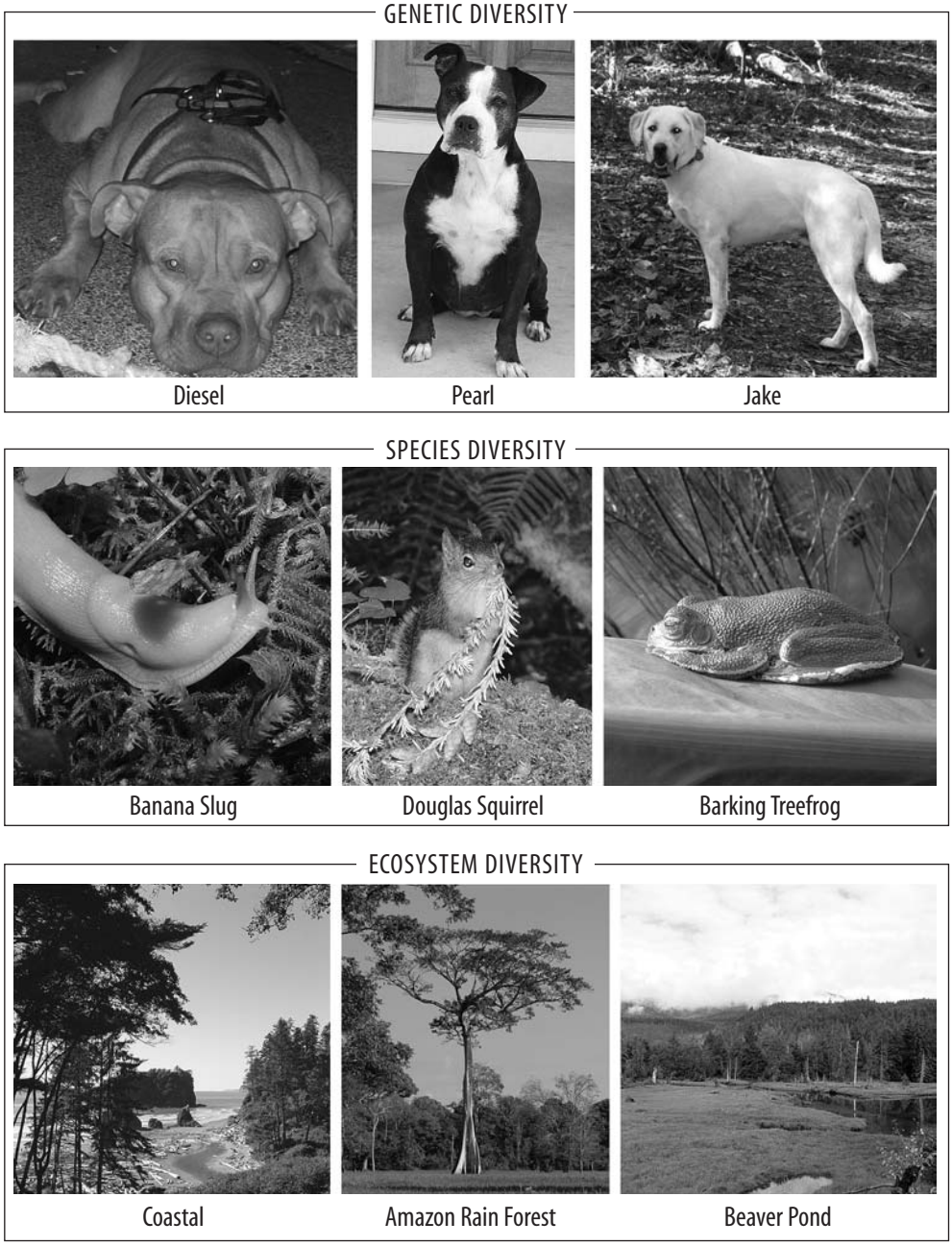
Next lead a discussion about the practical value of biodiversity. Ask students to think of things that they get from nature; write them on the board. Supplement the students' list with services from nature that may be new to students (e.g., providing clean air and water, pollination of food crops, and medicines). Discuss whether we can get these things from a source other than nature. (For additional information on ecosystem services see http://www.esa.org/ecoservices/). An interesting extension would include an examination of the economic costs of losing or replacing these "services." This may allow teachers to incorporate mathematics into the lesson and will highlight that in addition to the ethical and aesthetic value of biodiversity, there is also economic value.

Part 6

Discuss some of the causes of biodiversity loss. This discussion may be supplemented with illustrations of slash-and-burn agriculture, satellite photos of soil erosion, and photos of endangered and extinct species of plants and animals. Special note should be given to those extinct plants and animals that may have provided a service to humans. For example, a recently extinct frog (the gastric brooding frog) brooded its eggs in its stomach, which required that the frogs stop the secretion of digestive acids. Many doctors and medical researchers were interested in this ability because they believed it would provide important insights into the medical treatment of humans who suffer from ulcers or other gastric problems. However the species went extinct before it could be studied (Semeyn, 2002).

Figure 2: Levels of Diversity

Example images for illustrating the meaning and components of biodiversity. **Genetic diversity** is illustrated by different breeds of dogs. All domestic dogs belong to the same species (*Canus domesticus*) but are physically and genetically distinct. **Species diversity** is illustrated by three distinctly unique species of animals. Lastly, **ecosystem diversity** is illustrated with images of different types of easily distinguishable ecosystems. Dog photos (left to right) were provided by T. Bryan, K. Vleit, and J. Wilson. All other photos were taken by M. W. McCoy.



Part 7

Brainstorm with the class about ways that humans can help slow or stop biodiversity loss. For example, recycling, voting, reducing pollution, etc. Lastly, it is always nice to end on a positive note. End the discussion with an example of a conservation success story, such as the American bald eagle or the recent discovery of the Ivory-billed Woodpecker (which was presumed extinct). Make sure students understand that they can make a difference.

Impact of Activity on Students

We have presented this activity to more than 300 seventh and eighth-grade students at a middle school in Gainesville, Florida with a high proportion of disadvantaged students. In total, we presented the activity to six seventh-grade and five eighth-grade classes. It resulted in considerable discussion, with all students participating. We had four primary goals:

1. that students recognize their own value of biodiversity
2. that conserving biodiversity is an ethical as well as economic matter
3. that students gain a conceptual understanding of biodiversity
4. that students recognize the far-reaching impacts of human-mediated loss in biodiversity.

We found that more than 95% of students preferred all of the images that illustrated high diversity, and that they did so even before they knew the purpose of the activity. We asked the students who picked the most diverse images why they chose them. Most, however, could not give us a concrete reason—they typically replied, "I just liked it better" or "I just like the more colorful pictures." We also asked the students who had not picked the most diverse images why they chose the less diverse images. In these cases, the students preferred the order and structure of the less diverse images. For example, one student said that the rainforest picture "looks messy" and another said "The forest is scary." Despite this preference for order and fear of the unknown, these same students did appreciate the importance of biodiversity when questioned further.

In addition to the students recognizing that they preferred biodiversity, they also developed a solid conceptual grasp of what biodiversity is. All of the students correctly identified the most diverse images in Part 3 of this activity and nearly all of the students were able to accurately identify more and less diverse habitats when shown pictures of habitats they had not previously seen. This activity illustrated to us and to our students that E.O. Wilson's premise of biophilia may be true and that we, as humans, *do* have an innate attraction and fondness for biodiversity.

Summary

Many papers and lesson plans have been published on the value of going outside or "into the field" to teach about topics related to biodiversity (e.g., Zervanos & McLaughlin, 2003; O'Neal & Skelton, 1994; Beiersdorfer & Davis, 1994). However, there has been much less published about effective alternatives, when field trips are not an option. In this lesson we present a unique in-class exercise that incorporates abstract depictions of diversity as well as photographs of nature to teach the concept of biodiversity. In addition, our lesson incorporates a strong values-based perspective. Students learn that there are a variety economic and social reasons why we should conserve biodiversity and that there are also some very real ethical reasons.

Acknowledgments

We thank Sylvia Brooks for helpful suggestions in the preparation of this manuscript and Kent Vleit, Teresa Bryan, and Jackie Wilson for photographs of their dogs for Figure 2. We also acknowledge the National Park Service, NASA, and the United States Department of Agriculture for photographs acquired from their Web sites for use in Figure 1. Three anonymous reviewers provided insightful and helpful comments that helped improve the manuscript. Funding and inspiration were made possible by an NSF GK-12 Grant to the University of Florida.

References

Balmford, A. et al. (2002). Ecology – Economic reasons for conserving wild nature. *Science, 297,* 950-953.

Beiersdorfer, R.E. & Davis, W.E. (1994). Suggestions for planning a class field trip. *Journal of College Science Teaching, 23*(5), 307-311.

Costanza, R. et al. (1997). The value of the world's ecosystem services and natural capital. *Nature, 387,* 253-260.

Kareiva, P. & Marvier, M. (2003). Conserving biodiversity coldspots. *American Scientist, 91,* 344.

Leakey, R. (1996). *The Sixth Extinction: Patterns of Life and the Future of Humankind.* New York: Anchor Books.

Meffe, G. & Carroll, R. (1997). *Principles of Conservation Biology, 2nd Edition.* Sunderland, MA: Sinauer Associates.

Myer, N. (1996). Environmental services of biodiversity. Proceedings of the National Academy of Sciences, *93,* 2764-2769.

Myer, N. & Simon, J. (1994). *Scarcity or Abundance? A Debate on the Environment.* New York: W. W. Norton & Company, Inc.

Myer, N. & Kent, J. (2004). *The New Consumers: The Influence of Affluence on the Environment.* Washington, DC: Island Press.

O'Neal, L. & Skelton, J. (1994). A field trip to the rocky mountains to teach undergraduate ecology. *The American Biology Teacher, 56*(4), 233-237.

Semeyn, E. (2002). *Rheobatrachus silus*. Animal Diversity Web. Available online at: http://animaldiversity.ummz.umich.edu/site/accounts/information/Rheobatrachus_silus.

Wilson, E.O. (1984). *Biophilia.* Cambridge, MA: Harvard University Press.

Zervanos, S.M. & McLaughlin, J.S. (2003). Teaching biodiversity & evolution through travel course experiences. *The American Biology Teacher, 65*(9), 683-688.