

MAKING DECISIONS ABOUT BIODIVERSITY CONSERVATION: A STUDY IN PRE-SERVICE TEACHER EDUCATION

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Abstract

Biodiversity conservation is a current environmental concern that reveals the competing priorities of economic development and environmental preservation. These issues are currently being debated at various levels of society, and decisions are made based not only on scientific knowledge but also on opinions and values. Among the reasons commonly used to justify current environmental demands for biodiversity conservation, Sarkar (2005) has identified three “flawed arguments” to be avoided. Because the discussion of biodiversity conservation is a current demand, it should also be addressed in the field of education. Biology teachers should be prepared to engage their students in discussion about all aspects of biodiversity conservation. In light of the need to train professionals who are capable of addressing complex issues such as this, the following may be asked: What do biology students consider when making decisions about the use and conservation of biodiversity? Do the flawed arguments identified by Sarkar (2005) factor into their reasoning? This research analyzes reports produced following a teaching activity known as “decision making.” The results reveal not only students’ concern for environmental issues, particularly regarding water resources, but also the presence of two of Sarkar’s flawed arguments. The limits of students’ knowledge of the subject also become evident.

Key words: *biodiversity conservation, pre-service training, decision making.*

Introduction

The environment is constantly changing and Earth has undergone several periods of transformation throughout its history. However, it must be considered that despite the constant and natural changes, every natural ecosystem on the planet has been transformed through human activity and such modifications have reached great proportions. This intense degradation of natural environments as a result of human activities has become a major concern of society.

The natural world is a far different place now than it was many years ago; for example, many species have gone prematurely extinct (Groom; Meffe; Carroll, 2006). According to Primack (2010), biological communities are being devastated by human actions and the popular interest in protecting the world’s biological diversity has been intensified during the last few decades. Reducing the loss of biodiversity and ecological systems has come to be identified as one of the main challenges for humans for the coming years (Groombridge & Jenkins, 2002).

Although the term biodiversity has by now been incorporated into not only everyday vocabulary but also the concerns of a large segment of society, it is nevertheless difficult to arrive at a precise definition of biodiversity because, as several scholars have noted (Sarkar, 1999; Dreyfus, Wals, Weelie, 1999), the term is viewed differently depending on the objectives established. Considering the difficulty of defining the term, biodiversity may be viewed as

referring to diversity at all levels of biological organization, from alleles to populations, species, communities, and ecosystems (Sarkar, 1999). In light of environmental changes and established interactions, it may be argued that the term refers to the variety of life forms produced by long evolutionary processes, including the diversity of organisms that inhabit a space, genetic diversity, and the ecological complexity of a physical environment, in addition to the variety of biotic interactions and other biological processes (Based on Redford & Richter, 2001).

Concerns over the disappearance of species and the consequences of the destruction of numerous environments rich in biological resources came to prominence during the 1970s. For many years, demographic growth and the over-exploitation of resources were blamed for the destruction of a natural patrimony that had been millions of years in the making. Discussions on the increasingly rapid rates of species extinction and the destruction of nature due to human activities in the early 1980s led to debate over the impact of biodiversity loss on ecosystem functioning.

According to Sarkar (2005), our concern for the environment is related to two myths that profoundly influence our ideologies: the “myth of lost futures” and the “myth of a golden age.” In the myth of lost futures, concern for the environment stems from a fear that if environments are destroyed, then the future will be reduced to only a few options. Humans would face a future of limited environmental resources, with consequences for both the economy and scientific development. In the myth of a golden age, in turn, economic development and technology are viewed as sources of evil that are responsible for degrading humans from their primitive state and leading to environmental destruction because the former balance between nature and humans was lost.

Understanding the myths that directly influence the nature of concern for biodiversity makes it possible to distinguish among different perspectives regarding the need for biodiversity conservation adopted by different groups. These views include: biodiversity as an economic resource whose value must be determined so that it can be conserved in accordance with the value established; biodiversity as a scientific resource that should be conserved to be studied and exploited to produce benefits; and biodiversity as a symbol of the natural environment that should remain isolated from humans and conserved to reestablish the balance between humans and nature. These and other perspectives can be identified in the environmental debates that currently permeate society.

In search of answers to the concerns and challenges related to biodiversity conservation, the debate has extended beyond academic circles and spread to other realms of society, including numerous projects and campaigns undertaken by the general public with the intention of protecting and conserving the environment. In both research and teaching, different fields of knowledge have incorporated aspects of ecology and the environment. One example of this broad debate is the emergence of the fields of environmental law and ecological economics. The environmental movement can be cited as one of the activities in the social domain. According to Castells (2001), the term refers to collective behaviors and practices that aim to change perceptions and attitudes regarding humanity’s relationship with the natural environment. Environmentalism has a significant impact on society’s values and institutions but often bases activities on a discourse that is limited to “environmental crisis” and considers only the idea of humanity as a destroyer of nature. In the realm of politics, environmental agreements and incentives that favor the formulation of conservation laws have been established in a number of countries.

Sarkar (2005) believes that many plausible arguments, including concern for human and planetary quality of life, can justify an interest in biodiversity conservation. However, fiery rhetoric about an “environmental crisis” may lead to a loss of credibility for those who defend biodiversity conservation and increase decision-makers’ skepticism toward their claims. The author warns that this situation and the use of inconsistent arguments can do great harm and should be avoided. According to Sarkar (2005), the three “flawed” most often invoked to justify current environmental demands for biodiversity conservation that should be avoided are i) all

species are crucial to the continuity of life on Earth; ii) biodiversity conservation is a version of the “tragedy of the commons” in which free access and unrestricted demand for a finite resource end up dooming the resource to over-exploitation; and iii) a population explosion will lead to the loss of biodiversity.

These arguments hinder an understanding of the real-life dimensions of the problem, in which environmental questions weigh humans’ need for survival against the priorities of conserving all forms of life, from where a problem emerges: how to sustain a whole diversity of life in a world of use? According to Redford & Richter (2001), all use has consequences; different kinds and intensities of human use affect various aspects or components of biodiversity at different levels. Besides, an individual or societal decision on the degree of impact on biodiversity that is “acceptable” depends on scientific knowledge as well as on society’s values.

Because the discussion on biodiversity conservation is a pressing current issue, it should also be relevant to the classroom. Biology teachers should be prepared to engage their students in discussions about all aspects of biodiversity conservation (social, ecological, and economic), contributing to the development of a just society that takes ethical stands. In light of the need to train professionals who are capable of addressing complex issues such as this, the following may be asked: What do biology students consider when making decisions about the use and conservation of biodiversity? Do the flawed arguments identified by Sarkar (2005) factor into their reasoning?

Methodology of Research

General Background of Research

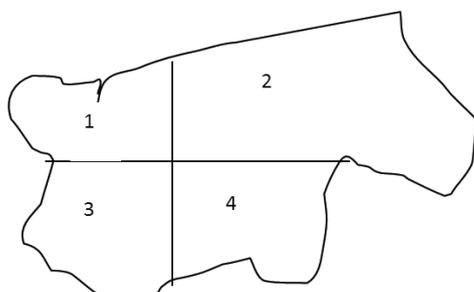
The planning of actions in biodiversity conservation usually involves groups or institutions with different objectives, responsibilities, and interests. It also includes several alternatives to minimize environmental problems, mainly regarding cost and benefits, making the selection of alternatives a complex task, which requires options for dealing with conflicts. This research aims to present an approach based on a model for group decision-making. This approach was applied to a group of students by means of an illustrative activity. The students were requested to think as “decision-makers”.

Sample of Research

The simulation was performed with university students studying the Biological Sciences at two Brazilian public universities. The activity was applied in two classes of each university. The students were attending the Environmental Education course and the activity was applied during such course. The four classes were divided into small groups that produced 21 reports, which were the object of analysis of this research.

Instrument and Procedures

The data were collected via an educational activity called “decision making”, which consisted of a map of a region divided into four areas, showing the main characteristics of each area and descriptions of the local species and the corresponding value attributed to each (Figure 1). A simulation was performed in which an environmental consulting firm was requested to issue a technical report about the region and the students had to choose which of the four areas should be selected for the installation of a new waste landfill, for urban expansion, and for environmental conservation.



Information:

- Area 1 – Greatest diversity of water resources
- Area 2 – Presence of unexplored mineral deposits
- Area 3 – Most level topography
- Area 4 – Presence of indigenous population (without officially recognized boundaries for a reservation)

	Characteristics
Species A	Flagship species
Species B	Keystone species
Species C	Species with economic value
Species D	Species with nutritional value
Species E	Species with medical value
Species F	Species with religious value
Species G	Species with biotechnological value
Species H	Species with productive value (domestication)
SpeciesM	Species on the IUCN list of endangered species
Species N	Species on the Brazilian Environmental Ministry's list of endangered species

Figure 1: Images of the activity called “decision making”.

The students were organized into groups. The activity was divided into two stages:

- (a) Developing the environmental impact report: Students were asked to describe the main problems of the area, identify possible alternatives for action, and review and evaluate the criteria that are relevant to decision making.
- (b) Socializing and discussing the decisions proposed in the reports produced: Students were to present their reports, detailing the decisions made and the respective criteria used.

Data Analysis

A total of 21 reports were analyzed, which were separated into “University A,” numbered from 1 to 10 (A to J), and “University B,” numbered from 1 to 11 (A to K). Bardin’s method for content analysis (2009) was employed with regard to the environmental issues identified by the students, the decision-making criteria and the possible conservation actions to be taken. This step was followed by an analysis using the categories previously established by the researcher: the three flawed described by Sarkar (2005) used by students to justify their decisions. Finally, the reports were characterized according to the social and economic aspects that influenced biodiversity conservation. The analysis focused on the reasons that were used by the students to justify their choices. The decisions themselves were not evaluated in regard to their correctness but instead in terms of the perspectives of future professionals who will address the questions under discussion.

Research Results

A general analysis of the reports revealed 10 distinct environmental problems with regard to the situation posed by the study (Table 1).

Table 1. Environmental problems related by students.

List of problems	Number of reports in which it is cited
Availability of water resources	14
Lack of officially recognized boundaries for an indigenous reservation	12
Pollution of water resources	8
Loss of keystone species	8
Loss of flagship species	8
Loss of endangered species	3
Loss of endemic species	3
Edge effects	3
Dam for the construction of a hydroelectric plant	1
Competition among relocated species	1

There was considerable concern over the lack of officially recognized boundaries for the territories of indigenous communities and populations as well as the availability of water resources. Regarding water resources, concerns focused on both their availability for human use and the potential misuse of an area rich in water resources, which could lead to water pollution. Table 1 shows excerpts from students' reports in which this last concern is evident.

Table 2. Environmental problem: water resources.

Report	Excerpt from the report
University A - 4	"We know that Area 1 contains the greatest diversity of water resources, which are crucial for the maintenance of the other areas under consideration; therefore, any change in this area may harm not only the area itself but also the other areas noted."
University A - 6	"Area 1 should not be degraded under any circumstances because of the water resources."
University B - 2	"Because we have a priceless water resources in Area 1, water pollution may harm the entire ecosystem."
University B - 7	"The installation of a waste landfill in an area with water resources would result in water pollution, including of springs and other spaces, harming the species that help maintain these resources."

Some reports revealed more specific concerns, as shown in Table 1. These types of concerns show that few students understand the complexity of environmental processes and the respective difficulty of maintaining the human way of life, which consumes many natural resources.

In most cases, the criteria used by the students to determine the areas that should be a priority for conservation consisted of listing the relevant factors for each area and then choosing the area with the longest list of factors to be conserved. In some reports, the students attributed weights to each factor; for example, the maintenance of water resources in Area 1 weighed more heavily than any other factor on the conservation decision. The presence of the indigenous population in Area 4 also weighed heavily in students' decisions: of the 21 reports analyzed, 15 chose Area 4 for conservation. The level topography of Area 3 was also used as a criterion, favoring the installation of the sanitary landfill in most reports and urban expansion in others.

Regarding the actions proposed by the students, 14 reports recommended solutions that involved relocating species from one area to another without any consideration of the difficulty of this practice. The creation of parks or reserves also appeared among the recommendations in several reports, but the students did not go into any detail about these, perhaps because they lacked knowledge about the different types of parks and reserves that exist.

The environmental problems, criteria, and actions listed by the students were analyzed for the presence of Sarkar's flawed arguments (Sarkar, 2005) in the decisions about which areas to conserve. The results are shown in Tables 3 and 4.

The first flawed argument appeared in 11 reports. The students prioritized the conservation of areas with the largest number of species as well as areas with endemic and flagship species in particular, arguing that the loss of these species would harm the environment. In some cases, it was claimed that this could harm humans. According to Sarkar (2005), species become extinct, and other beings live on. Additionally, it is not known which species' loss may mark the end of the biological world. This argument would hold that only species crucial to the local community—keystone species—should be conserved. Several reports prioritized the conservation of keystone species' habitats, but two reports suggested that these keystone species be relocated to other areas, demonstrating a lack of scientific knowledge about the role that these species play in the environment.

Table 3. Presence of first flawed argument: "All species are essential".

Criterion	Reports – University A	Reports – University B
Conserve an area due to the presence of endangered species, flagship species, and species that are useful to humans	A, B, E, D, J	A, D, F, G, H, I

The second flawed argument appeared in 13 reports. In determining their conservation priorities, these students opted for isolating certain areas from human presence, for example, through the creation of reserves. The report from University B-11(K) reasons that Area 1 should be conserved for the following reason: "The human population would not respect the water resources." The students considered that the State or private enterprise would have to administer the natural resources because free access to the area would lead to its destruction. Sarkar (2005) believes that environmental administration by the government or private enterprise has had mixed results over the years. Thus, control may represent an area's destruction rather than its conservation.

Table 4. Presence of second flawed argument: "Tragedy of the commons".

Criterion	Reports – University A	Reports – University B
Conserve an area because free access to its resources could result in their destruction; a park, reserve, or preserve should be established.	A, D, C, F, G, H	B, D, E, F, G, J, K

The third flawed argument was not found in any of the reports. The reports identified problems related to the quantity or use made of available resources and environments but not to global population growth. A population's way of life directly influences biodiversity conservation in that it determines the amount of environmental resources that are needed to maintain it. Proposed solutions include conscientious use, the local control of resources, and alternatives such as sustainable communities.

Discussion

In the reports, it is possible to identify the students' difficulty in balancing the economic, social and environmental interests to establish the priority areas for conservation and also the lack of knowledge of most of the students regarding current concepts related to biodiversity conservation. For example, the keystone species was the most consulted concept by the students. The concept of keystone species is of major importance for the study of the ecology of ecosystems since they play a fundamental role in them. The withdrawal of a keystone species from its environment has many negative consequences. However, in some reports, the students decided to remove a keystone species from their place of origin and justified that the damages would not be great.

The general nature of the reports showed that the students prioritize economic, and especially ecological and biological, aspects in their decision making. The social aspects discussed were always related to maintaining indigenous populations in their homelands, a situation which was not addressed in six reports. According to Schaller (2007), conservation problems are only social and economic, not scientific. The research is the easiest part, and conservation is definitely much more complicated since environmental issues often involve moral ambiguity.

A possible cause for the predominance of ecological and biological aspects may be related to the structure of the university's program: fragmentation of knowledge, the absence of courses in which this type of discussion occurs, limiting the understanding of the complex relationships that biodiversity conservation entails.

The presence of flawed arguments and the focus on the interests of human beings confirm the tendency found by Almeida (2007). In their research, biology teachers were asked about the criteria that should be used to save endangered species, and most of them chose species that are useful for humans.

According to Clement (2004), such positioning is related to the interaction between the disciplinary formation and the geographical origin of the value system. In a research on nature and environment carried out with future Biology teachers, 67% of German biologists prioritize the interests of human beings, while 72% of French biologists prioritize the interests of the environment itself. In accordance with the author, one of the possible hypotheses for interpreting this relationship would be that training biologists do not explicitly have specific values and are more permeable to the values of the sociocultural context of their country, which would differ among countries.

Conclusions

This analysis reveals the limited view of biodiversity conservation held by the students. Their reports and discussions remained fixed on very general aspects, frequently shaped by conceptions spread by the media. The discussion did not delve into social, political, or philosophical questions related to the topic, and even the discussion of biological issues remained superficial.

Specifically, the presence of two of Sarkar's three flawed arguments in students' reasoning about biodiversity conservation may indicate that the education of biologists should extend beyond scientific content to include the ability to address the values and practices of contemporary society that are relevant to decision making and public policy planning.

During the presentation of their reports, the students emphasized that they rarely have an opportunity to think about a problem and propose solutions to it. Therefore, it is necessary to invest in an education that favors the development of knowledge about relevant aspects of biodiversity conservation, coordinating studies performed by scientific communities with field work in a manner that teaches students to reflect on how to solve environmental problems considering the values and practices of each natural environment.

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