

Learning the role of biodiversity monitoring in a biosphere reserve

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Supporting Information Placeholder

ABSTRACT: Biosphere reserves have long been considered a place for learning about the environment, biodiversity and conservation, and sustainable development. While environmental education can be one of their mandates, many other institutions or organizations can play a contributing role in this matter. In this paper, I present how my UNESCO Chair and Brock University decided to contribute to this learning function through the development of a course called “Biodiversity in a biosphere reserve”. This course is based on experiential learning and aims to give students practical skills in how to monitor ecosystems. The use of permanent biodiversity monitoring plots allows for the possibility to accumulate data over time and therefore monitor how diversity on terrestrial and aquatic ecosystems near Brock University varies over time. Such courses are being developed in other universities and allow to contribute to the learning function of the biosphere reserves. They should be promoted not only in universities but also in colleges and other institutions.

Keywords: education, biodiversity, field course, experiential learning, monitoring, permanent biodiversity plots

Introduction

Environmental education has been promoted since the 1970’s with the recommendation 96 of the Plan of Action adopted by the UN Conference on Human Environment held in Stockholm. This recommendation requested that UNESCO and UNEP work together to develop an international program in environmental education (Kassas 2002). Since, several actions have been undertaken to integrate environmental education in different programs at the

international level. Another program launched in 1971 would also contribute to environmental education. This program, the UNESCO’s Man and the Biosphere (MAB), aims to be the “interface between nature conservation, interdisciplinary research and monitoring and educational prerogatives in the ecological and environmental sciences” (Ishwaran et al. 2008, p. 119). In Rio Summit in 1992, additional concepts were introduced and encouraged to be part of any environmental education programs. This included the concept of sustainable development and with the adoption of the Convention for Biological Diversity, the importance of biological diversity conservation.

Environmental education has taken different forms depending on the emphasis of the educational programs and the audience (Kassas 2002) as well as which institutions or organizations are promoting it. In universities, for example, environmental education may target many disciplines such as biology, sustainability science, environmental studies, education, and social sciences. In each case, the content may differ and emphasis can be put more on ecological concepts in biology than in education where a more general concept can be used. In biology, assessing biodiversity aids in understanding the ecological health of a system. For example, invertebrates and plants share important and distinct roles in maintaining ecosystem function and services. Equally important is their response in species richness and abundance following changes in the ecosystem’s environmental factors. Monitoring community properties allows us to see the change in composition over time in response to alterations to physical factors, and renders crucial information on the ability of an ecosystem to respond to change and how its overall health and functionality are affected over time.

Through these different iterations of international conventions and changes in environmental education programs, organizations such as UNESCO also evolved. For example, the MAB program has modified its mandates over time and integrated several of these new conventions or concepts (e.g., sustainable development and climate change). For example, the Seville Strategy emphasizes the importance “to support demonstration projects, environmental education and training and research and monitoring related to local, national and global issues of conservation and sustainable development” in biosphere reserves, thus adding sustainable development in their agendas (UNESCO 1995). Over time, the functions of education, research, and long-term monitoring remain important but with variations in how it should integrate various concepts. In the Lima Action Plan (MAB 2017), education remains central and expressed in its strategic objective #3 “Facilitate biodiversity and sustainability science, education for sustainable development (ESD) and capacity building” (p. 17).

In this paper, I describe the development of a course related to environmental education that examines mainly biodiversity and ecosystem health in a biosphere reserve. This course was developed as part of the proposal of the development of my UNESCO Chair in Community Sustainability: from Local to Global. I discuss how this type of course can be used in many other formats in connection to biosphere reserves. There are already a few others but the number could increase over time and the possibility to link them as a network could present a great opportunity for exchanges and collaborative learning.

Developing the course at Brock

Brock University was built before the establishment of the Niagara Escarpment Biosphere Reserve (NEBR) in 1991. This means that when the core area was delimited, some of the buildings that were already present at Brock were included. The campus is therefore in a unique situation as there is an opportunity to link some of the mandates of biosphere reserves with the environmental educational experience on campus. Interestingly, during the development of my UNESCO Chair, I discovered that very few courses at Brock mentioned this unique situation and examined and educated some of the mandates of a biosphere reserve. Environmental

education being one of the mandates of UNESCO programs, including the Man and Biosphere program, it was felt that there was an opportunity to develop a course that would encompass concepts such as biodiversity, ecological monitoring, ecosystem health, and sustainability (Box 1). The reasons for creating a new course came from students in the Ecology stream at Brock requesting more practical and experiential courses in the field and few of our courses dealt with the interdisciplinarity required for new graduates working in ecological / environmental fields. The other reason was why not take advantage of being directly related to a bio- sphere reserve to develop a course that would enhance the awareness and knowledge of biosphere reserves, importance of conservation and sustainability. The learning objectives of this course are included in Box 2 and many of them are directly related to practical skills.

The development of the course is based on my experience with the defunct Ecological Monitoring and Assessment

Box 1. Course Description

Introduction of the concepts of Biosphere Reserves and the importance to protect biodiversity. This course deals with the issues of ecosystem survey and long-term monitoring of changes due to human activities and environmental factors (natural and anthropogenic). It examines natural versus urban ecosystems based on integrative studies from the biological, geological, geographical, management, social, and economic perspectives. The course will introduce students to sampling design and techniques, treatment of data incorporated in fieldwork, labs, lecture-discussion, and integration of various concepts through team projects and report preparation.

Network of Environment Canada and the protocols that have been developed over the years including the establishment of permanent biodiversity monitoring plots. The course includes several components related to the topics of biosphere reserves, biodiversity, ecosystem monitoring, and sustainability. The first day starts with training in field safety and the basic concepts of Biosphere Reserves, biodiversity and ecosystem health. Students also learn about rapid assessment, field practices and installation of the biodiversity monitoring plots. The importance of appropriately recorded information, observations and data is introduced and independently kept field

journals and computer files are assessed at the end of the course. The students also enjoy the presentation by the Niagara Escarpment Biosphere Reserve by someone from the Niagara Escarpment Commission, so they understand the background related to biosphere reserves, their mandates and principles and what the Niagara Escarpment is. Most of the rest of the two full weeks (12 days) are spent in the field.

Box 2. Learning Objectives of the Course

- Acquire general knowledge and understanding of the concepts, theories and methodologies in ecological monitoring of biodiversity and the importance of biosphere reserves (interdisciplinary issues)
- Ability to collect data in the field in different ecosystems;
- Ability to use data for analysis and ecosystem health interpretation, i.e. critical thinking
- Ability to integrate ecological knowledge using the appropriate methodologies with other disciplines such as mathematics, geography, sustainability science, etc.
- Ability to synthesize information and communicate appropriately (in writing and orally)
- Understand the limits of knowledge in monitoring but its essential role to assess human impacts on ecological systems
- Ability to write and work in teams or individually

The format of the course is based on participative learning in the field. It is expected that students will be actively participating in the field activities throughout the course. Attendance is therefore mandatory as data are collected in the field in teams. Because of the importance to maintain standards, students learn and must work in a safe, collaborative and integrated manner. To excel in this class, students must bring their own expertise and with appropriate preparation are able to effectively use the appropriate techniques. Participation level have also demonstrated students' capacity to do teamwork which is essential in research and monitoring. They learn how to identify, measure, and map trees in their plots, inventory of shrubs and ground vegetation, monitor salamander populations, conduct insect and bird surveys, etc. They also collect soil samples to measure basic soil properties and nutrients. The locations of

these permanent monitoring plots are in the Niagara Escarpment directly and in another younger forest located on Brock and HydroOne properties. The advantage of having two sites is that students can compare two forests of different ages and having had various human activities (as Brock was farmland previously).

The course is not limited to terrestrial systems. The second part of the course examines the aquatic ecosystem of Lake Moodie, which is adjacent to Brock and has had a history of human activities that makes it interesting to monitor. In this case, students learn about shoreline vegetation, and collect benthic and water samples for analyses in the lab. For most of these analyses, we used the standard protocols that are currently in use such as the Ontario Ministry of Natural Resources protocols for salamanders (under the Brock University approval by the Animal Care Committee) and benthic sampling, and point counts for bird surveys. All plots and sampling transects are also georeferenced using a GPS unit. Brock University has a map library and access to ArcGis and therefore students have also a training component on the geographic information system and learn to produce their own maps with the locations of their plots and transects.

Niagara is mainly located in a rural region where many activities can impact on biodiversity conservation and sustainable development. During the course, a few field trips are also organized to give other perspectives of the different zones of the NEBR. For example, we usually hike the Niagara Glenn where students are observed different flora as well as discuss the challenges related to tourism in such a fragile environment (as well as the issue of noise pollution coming from helicopter rides and speed boats for the Whirlpool of Niagara River). Since the rural component of the region is quite significant with vineyards and farms, visits have been organized in sustainable vineyards and organic farms. In each case, students can learn how some farmers are changing their way of farming to improve sustainable practices and protecting the environment. From these visits, students have to reflect in their journals on the advantages/disadvantages of human's proximity to nature and how coexistence can be achieved through more environmentally friendly practices.

The last part of the course includes a project that as a team they must define and carry out. This gives students the opportunity to go further in examining a specific aspect of the ecosystem using the scientific method. Projects can be quite diverse from testing a bryophyte inventory protocol and compare between both forests to comparison of different insect or benthic communities in other locations in the Niagara region with their own data from the permanent plots. They then write a report and present to the rest of the class their results (both components being evaluated). Evaluation of the students also includes an essay on topics that are added on a yearly basis such as climate change and invasive species as well as the comparison of sets of data coming from previous years to assess data quality and changes over time.

The advantage of having permanent monitoring plots is that students can return to these plots every two years (as the course is now taught every two years) giving the opportunity to examine changes over time. This has been an important issue as the younger forest at Brock was mainly composed of ash trees, which suffered in 2015 the infestation of the Emerald Ash Borer. This infestation has significantly thinned the forest and over the next decades, it will be possible to monitor its recovery.

Opportunities for experiential learning in biosphere reserves

Practical learning in the field is not limited to Brock University as several other universities have established field courses on various ecological disciplines. The proximity of a biosphere reserve can give another spin to a course by adding a more interdisciplinary component such as sustainable development. Such courses should not be limited only to universities as many colleges may have the same capacity. It appears that biosphere reserves may have been a missed opportunity for environmental education. Some institutions (e.g. Waterloo and Queen's) have also taken advantage of the biosphere reserve system and have shown that courses can take different formats. Opportunities are limitless.

To ensure a more sustainable and resilient socio-ecological systems, education and life-long learning should be a central activity in communities worldwide. Acquired awareness and knowledge may help people understand the importance for

conservation and sustainable development to enhance resilience of communities (Lundholm and Plummer 2010). The education system, from elementary schools to universities and colleges, all have roles to play in enhancing awareness to these concepts of biodiversity, conservation, sustainability and resilience. However, due to very tight curricula, in most educational systems, these concepts are not often promoted. For example, examining the curricula in high schools in Ontario and interviewing teachers in Niagara, Janzen (2016) reports that such concepts are often left for the last month of the academic year in grades 11-12 due to lack of time to cover the mandatory basic modules. Due to limited resources, lack of time, and sometimes expertise of teachers, the capacity to bring students outdoors and deliver experiential learning on the environment has been reduced (MacMillan 2014). In many cases, awareness and knowledge are left to life-long learning organizations such as nature clubs or some summer camps. While these organizations may help promote experiential learning, they are limited to few interested participants. This means that people tend to become more and more disconnected to nature and awareness of its benefits are more difficult to convey (MacMillan 2014).

With the approval of the recent UN 2030 Agenda and the SDGs, it was suggested that biosphere reserves can serve as models where such activities that be promoted and examined to determine how they can be implemented in other communities. Educational institutions within or adjacent to a biosphere reserve can certainly engage with it and find ways to promote the concepts discussed in this paper. While field courses can be a very effective way to not only educate and train people in concepts such as biodiversity and ecological monitoring, they can help support the monitoring function of the biosphere reserve by accumulating and sharing data. Other modes of delivery can also contribute to specific projects or ways to promote the biosphere reserve activities. In the past few years, with the adoption of the UN Declaration of Rights of Indigenous Peoples and in Canada the Truth and Reconciliation Commission Recommendations, indigenous knowledge has also been introduced in the mandate of biosphere reserves as they represent an opportunity to learn and share knowledge on biodiversity. In the next iteration of my course at Brock, it is planned that indigenous knowledge will be introduced and students

will be able to learn about its importance for conservation, ecosystem health and sustainable development.

Ideally these activities are not only contributing to environmental education per se but also to a more social learning environment that stimulates critical thinking and reflection and can lead to potential actions and changes in behavior (Schultz and Lundholm 2010). However, in an international survey of 79 biosphere reserves, Schultz and Lundholm (2010, p. 658) report to have “identified three BRCs that seem to combine learning through adaptive co-management and environmental education on the ground”. However, should the burden of environmental education and social learning only be supported by the biosphere reserve organization? As the biosphere reserve can be considered as a partnership of organizations and institutions including the private sector in a specific area, it is therefore important for the managers of biosphere reserves to target the groups or institutions that can help support their mandates regarding environmental education. Indeed, as stated in the objective #3 of the Lima Action Plan (MAB 2017): “At a biosphere reserve level, this requires collaboration between all the different stakeholders, including scientists, policymakers, members of local communities and the private sector. ESD promotes the inclusion of key sustainable development issues in teaching and learning, to motivate and empower learners to change their behaviour through acquiring new skills, competencies and values, and to take action for sustainable development. Biosphere reserves, particularly through their coordinators, managers and scientists, have key roles to play in operationalizing and mainstreaming sustainability science and ESD at local and regional levels, in order to build scientific knowledge, identify best practices, and strengthen the interface between science, policy and education and training for sustainable development” (p. 19). In the future, for biosphere reserves, it is possibly a question of looking at how institutions and other organizations related to life-long learning can be involved in the environmental education and even monitoring mandates of the biosphere reserves. This can be a way for them to become more sustainable and more effectively promoted in their region, a challenge that most biosphere reserves are facing. In my case, I believe that through my UNESCO Chair I could at least contribute in a small way to this objective.

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