



## **Chapter 1: Biodiversity**

Science, Ethics, Spirituality, Action

<http://healingearth.ijep.net/biodiversity>

### *Introduction*

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The *Healing Earth* team asks that when you use any aspect of this teacher guide or the lesson modules that you please send an email sharing: 1) how you used the resource, 2) how your students responded to the resource, activity, or lesson, and 3) what changes you would recommend for future versions of the guide. Please email Dr. Michael Schuck ([mschuck@luc.edu](mailto:mschuck@luc.edu)) and Dr. Nancy Tuchman ([ntuchma@luc.edu](mailto:ntuchma@luc.edu)), the co-directors of the International Jesuit Ecology Project. The information that you share will help improve these resources for your and others' use. We appreciate your feedback.

### *Overview*

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The goal of this chapter is to understand the science behind biodiversity and link that understanding to ethical analysis, formation in environmental spirituality, and plans for action. In biodiversity education, science is just the starting point. An integrated understanding of biodiversity engages students more fully in the subject because it engages *them* more fully--connecting their scientific curiosity, their moral lives, their deepest beliefs, and their energy to act. By exploring biodiversity as only a science topic, it can be reduced in the student's mind to just another unit among others in an environmental science course. Without an integrated, interdisciplinary approach, students may neither grasp the full importance of biodiversity for life on Earth, nor sense the urgency of reversing our planet's declining biodiversity.

At the end of the chapter, students should be able to understand biodiversity, be familiar with the different biomes found around the world, and understand how human activity has had a devastating effect on biodiversity worldwide. Students should also be able to identify and ethically analyze the most important moral problems linked to declining biodiversity. In the process, students should also deepen in their personal appreciation for the meaning of biodiversity and, in that way, come to greater maturity in their own environmental spirituality. Finally, students should be able to identify actions that are being

taken in the world today to address the problem of declining biodiversity and imagine actions that they can take in their own communities.

### *Learning Objectives*

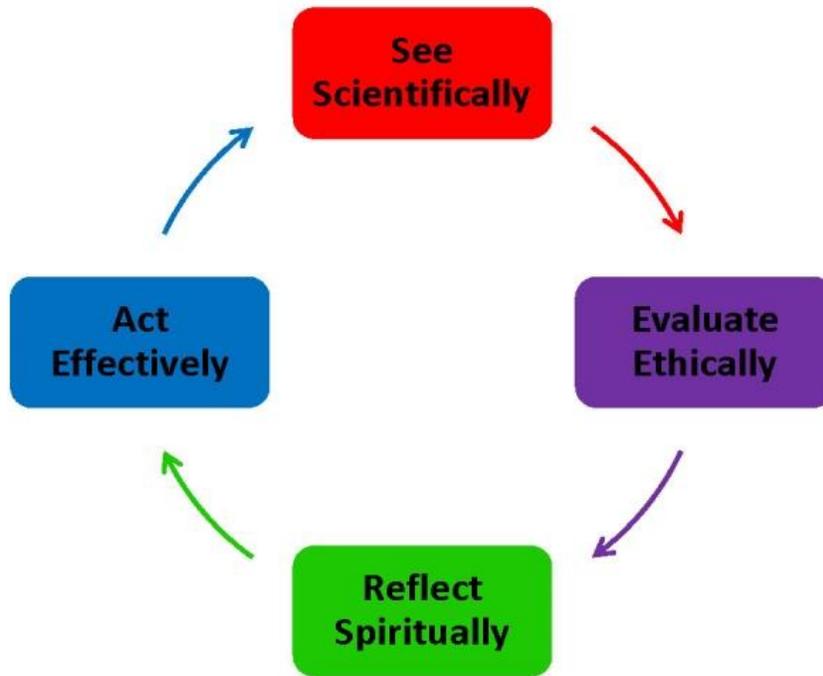
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1. Investigate a case study that raises key issues concerning **biodiversity**.
2. Identify the ecosystem **services** provided by biodiversity.
3. Explain the relationship between biodiversity and **evolution**.
4. Describe Earth's major **biomes** and aquatic ecosystems.
5. Discuss current major **threats** to biodiversity.
6. Analyze key **ethical challenges** concerning biodiversity and understand the moral principles, goals, and virtues important for guiding decisions that affect Earth's plant and animal life.
7. Describe the ways in which **spirituality** has influenced human understanding of biodiversity and recognize how spirituality can support a constructive response to **declining biodiversity**.
8. Learn about the **actions** taking place in the world today to address **threats** to biodiversity. Consider a possible action that addresses a biodiversity threat in your community.

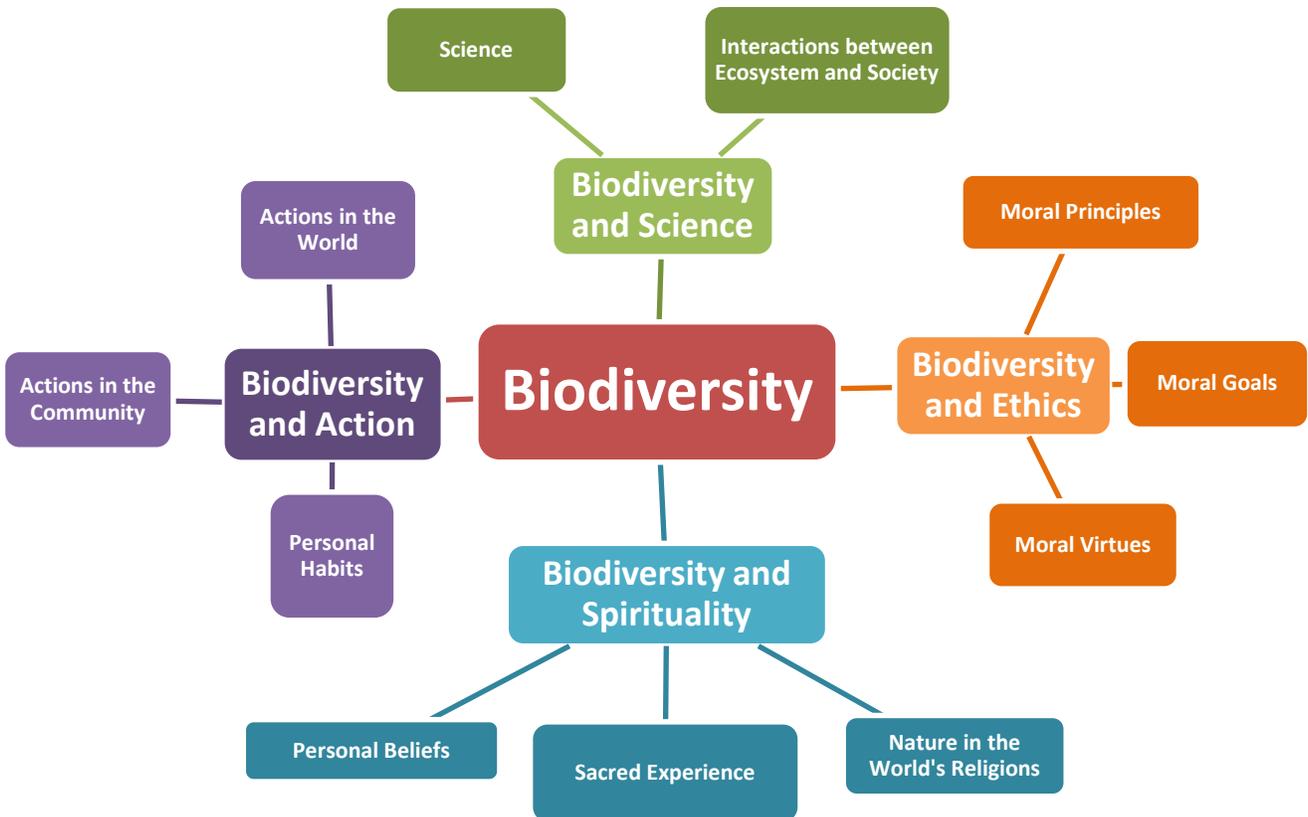
### *Connection of this Chapter to Ignatian Pedagogy*

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As stated above, an integrated understanding of biodiversity engages students more fully because it engages *them* more fully as subjects, as *whole human beings* invited to connect their scientific curiosity, their moral lives, their deepest beliefs, and their energy to act. This follows the spirit of Ignatian Pedagogy, the method at the heart of *HE*. In *HE*, you are first invited to “see scientifically” and relate what you see to your own experience. Next, you are asked to reflect on the values (“evaluate ethically”) and meaning (“reflect spiritually”) that emerge in the study of environmental science. Finally, you are challenged to take the knowledge you have gained and act to heal the Earth (“act effectively”).



When we elaborate this Ignatian Pedagogy figure with the major topics covered in the Biodiversity Chapter, the following graph emerges.



As teachers, we should be sensitive to the ‘entry point’ into the subject of biodiversity that attracts student attention. Possibly that entry point is science, or maybe a local environmental action linked to biodiversity is a better point of departure. In these cases, we can capitalize on local events and, from there, guide students to biodiversity science. The same can be true of a moral issue in biodiversity. Possibly students have an interest in species extinction, from which we can bring students to the science of biodiversity. The point to keep in mind is that the major topic areas in each *HE* chapter are movable; you can enter the chapter at any topic area and move along to the remaining topics in the order you find most helpful.

## *Lesson Outline and Suggested Activities*

Keep in mind that while the activities below are presented in a linear outline form, *Healing Earth* emphasizes an integrated approach that encompasses science, ethics, spirituality, and action. It is important that students do not see these as separate topics but as mutually reinforcing, interconnected dimensions of each subject, whether that be biodiversity, natural resources, energy, water, food, or global climate change.

<b>I. Case Study: Kakadu and the Mirrar</b>	<i>Raises scientific, ethical, spiritual, and action questions.</i>
<p>The chapter opens with a case study of the Mirrar People in the Kakadu Forest of Australia to pique student interest in biodiversity and its importance around the world. Topics that are introduced include but are not limited to:</p> <ul style="list-style-type: none"> <li>• Evolution</li> <li>• Diversity of biomes</li> <li>• Threats to biodiversity</li> <li>• Intrinsic value of biodiversity</li> <li>• Ethical issues related to biodiversity</li> <li>• Role of spirituality in biodiversity</li> <li>• Connection between sacred sites and biodiversity protection</li> </ul> <p>Have students compare and contrast this case study with other biodiversity challenges in the world or within their own communities. Highlight how science, ethics, spirituality, and action each factor into the Mirrar case. Use the questions below to explore the case.</p> <ul style="list-style-type: none"> <li>• Why is biodiversity important and how did it come about? What are the major biomes present on Earth?</li> <li>• What ethical challenges does Australia face in protecting the biodiversity of Kakadu? What ethical challenges do you face in protecting and preserving Earth’s biodiversity?</li> <li>• How have humans approached the nature and meaning of biodiversity from a spiritual perspective? What aspects of spirituality might we draw onto help us address the problem of declining biodiversity?</li> <li>• What actions are being taken in the world today that are hopeful signs for Earth’s biodiversity? What actions can you take?</li> </ul>	

You may also want to look at the reflection questions given at the end of this chapter and begin to ask some of them in ways related to the case study.

### *Reflection Activity*

For centuries, Indigenous People throughout the world have been working to maintain balance and harmony with the biodiversity that surrounds them. Research one of these Indigenous cultures and explain how their spirituality relates to biodiversity in their regions. Have a discussion with your peers about the challenges and successes Indigenous Peoples have had in conserving biodiversity.

## **II. Biodiversity and Science**

*Offers a solid scientific understanding of biodiversity.*

This section contains three major lessons:

- Biodiversity and the role it plays in evolution
- Geographic distribution of biodiversity and the different biomes present on Earth
- Causes of declining biodiversity on Earth

By the end of these lessons students should have a firm grasp on why biodiversity is important, how it came about, and what the major forms of biodiversity are on this planet. As you are going through the lessons, make sure to pay attention to the “Closer Look” and “Looking Ahead” boxes. These are links to the Ethics, Spirituality and Action Sections coming up which will help students begin thinking about the connections between science, ethics, spirituality, and action. Also, make sure that students are continually reflecting back to the questions and objectives explained at the beginning of the chapter. Try and make connections to the students’ own communities and interests.

### *Assignments/Projects:*

1. **Exploring and Categorizing Biodiversity** - Select two marine eco-regions or two freshwater ecosystems, and explore the biodiversity found in each habitat. Create a poster comparing and contrasting species in each ecosystem, the abiotic conditions (i.e.: temperature, nutrient and oxygen levels, water depth and flow rate, and precipitation patterns), and the particular ecosystem services provided by each habitat.
2. **Food Web** - Research some of the keystone species in the ecosystems in your region. On a large piece of paper, create a food web that relies on one of these keystone species trying to include at least ten additional species in your web. What happens to this food web when the keystone species is removed or goes extinct?
3. **Invasive Species** - In small groups, choose an invasive species that has affected a nearby ecosystem. Develop a presentation for your peers on how this species became established in a new location, how it impacts the native flora and fauna, and what approaches are being used to confront the invasive species.
4. **Measuring Biodiversity** – have students make an estimation of Simpson’s Index by

using 1 meter sticks and 4 flags to set up transects in a diverse area near a lake. Then have students count the variety of species in the transect to estimate biodiversity. Introduce students to Nature’s notebook ([https://www.usanpn.org/natures\\_notebook](https://www.usanpn.org/natures_notebook)).

5. **Virtual Labs**

Plant Transpiration

[http://glencoe.mheducation.com/sites/dl/free/0078802849/383946/BL\\_10.html](http://glencoe.mheducation.com/sites/dl/free/0078802849/383946/BL_10.html)

Natural Selection

[http://glencoe.mheducation.com/sites/dl/free/0078802849/383939/BL\\_12.html](http://glencoe.mheducation.com/sites/dl/free/0078802849/383939/BL_12.html)

Communities and Biomes

[http://glencoe.mheducation.com/sites/dl/free/0078802849/383927/BL\\_24.html](http://glencoe.mheducation.com/sites/dl/free/0078802849/383927/BL_24.html)

Ecosystems and Trophic Levels

[http://glencoe.mheducation.com/sites/dl/free/0078802849/383916/BL\\_03.html](http://glencoe.mheducation.com/sites/dl/free/0078802849/383916/BL_03.html)

**III. Biodiversity and Ethics**

*Shows the connection between biodiversity and environmental ethics.*

It is important that you understand the logic that holds together the environmental ethic presented in *HE*. As explained in the Teacher Guide Introduction, the ethic is built on three foundations: the intrinsic value of nature, the instrumental value of nature, and the value of sustainability. The value of sustainability should shape how we use of nature (instrumental value); by using nature in a way that neither exhausts nor degrades it, we honor the integrity of the nature world (intrinsic value).

From these foundations a set of moral principles, goals, and virtues are derived that aid us in thinking through moral challenges that surface as human beings interact with the natural world. The foundations, principles, goals, and virtues used in *HE* are rooted in Roman Catholic social thought. You can see how these are presented and employed in such texts as Pope Francis' encyclical [\*Laudato Si'\*](#) (2015), Pope John Paul II's message [\*The Ecological Crisis: A Common Responsibility\*](#) (1990), the Southern African Catholic Bishops Conference's [\*Pastoral Statement on the Environmental Crisis\*](#) (1999), the Australian Catholic Bishops' statement [\*A New Earth: The Environmental Challenge\*](#) (2002), or the United States Conference of Catholic Bishops' pastoral statement [\*Renewing the Earth: An Invitation to Reflection and Action on Environment in Light of Catholic Social Teaching\*](#) (1991). All these texts are available on the internet at the provided hyperlinks.

Understanding the background logic to *HE*'s environmental ethic is not, in the first instance, for the purpose of teaching it to your students. Rather, the purpose is to help you feel more comfortable taking a single foundation or norm and exploring it in depth *with* your students. You may, for example, wish to lead a class discussion on what the intrinsic value of nature means and what bearing this might have on the issue of species extinction. In other words, consider approaching the Ethics Section with an emphasis on *depth* rather than *coverage*. Your students may eventually develop a sense of what it means to have a coherent environmental ethic, but a better place to start is often with a specific ethical idea in relation to a specific moral problem.

There are many ways to conduct an informative exploration of environmental ethics as it

pertains to biodiversity. You may wish to facilitate small and large group discussion, a class debate, or a case study analysis.

### **Small and Large Group Discussion**

The following articles were gathered from three of the major regions of the world. Have students describe and discuss the moral problems that surface in various environmental challenges in the world. In particular, you can ask them to identify and discuss in small or large groups how the moral principles of intrinsic and instrumental value connect with each regional report.

*Europe:* There are 943 plant and animal species in England that have been targeted under the Species Recovery Programme to preserve biodiversity. Check out the [species of the month](#) and discuss how this program was a response to a moral problem.

*South Asia:* An invasive species originally known as “the mad one” was introduced to the Rajasthan Desert in India from Mexico in the 1930’s. [Read this article](#) from *The Guardian* newspaper to see how this species is impacting the restoration of natural biodiversity in the desert today; then discuss how environmental ethics connects with this situation.

*North America:* The New York Times reports that global climate change will have adverse effects on nearly half of North American bird species. Take a [look at](#) how the three-toed woodpecker, the northern hawk owl, and other birds will struggle to survive and discuss the moral problem that this situation raises.

### **Class Debate**

There are many ways to conduct a class debate. The following is one model that has been used by an *HE* teacher in connection with the Case Study for this chapter.

Ask your students to debate the following resolution: “It is morally acceptable to build a uranium mine in Australia’s Kakadu National Park.”

Create two debate teams with about four students on each team. One team takes the Australian Government side in favor of building the mine (AFF) and the other team takes the Aboriginal side in opposition to building the mine (NEG). The remaining students in the class can act as debate judges. Give your students the time and assistance they need to research the topic and build their arguments. Require that students use some of the moral principles, goals and virtues presented in *HE* in their arguments.

You could structure the debate as follows:

1. AFF 2-3 minutes opening argument
2. NEG 2-3 minutes opening argument
3. AFF 1-3 minutes defending one or two points in their position
4. NEG 1-3 minutes response/rebuttal to the AFF (no new arguments)

5. NEG 1-3 minutes defending one or two points of their position
6. AFF 1-3 minutes response/rebuttal to the NEG defense (no new arguments)
7. AFF 1-3 minutes with a second round defending one or two new points for their position
8. NEG 1-3 minutes response/rebuttal to the AFF defense in 7
9. NEG 1-3 minutes with a second round defending one or two new points for their position
10. AFF 1-3 minutes response/rebuttal to the NEG defense in 9
11. AFF 1-3 minutes with a third round defending one or two new points for their position
12. NEG 1-3 minutes response/rebuttal to the AFF defense in 11
13. NEG 1-3 minutes with a third round defending one or two new points for their position
14. AFF 1-3 minutes response/rebuttal to the NEG defense in 13.
15. Closing Arguments from the NEG side (2-3 minutes)
16. Closing Arguments from the AFF side (2-3 minutes)

Debate judges can evaluate each round and tally scores at the end, or determine the debate winner all at the end. Discussion should then ensue about the debate experience, how the judges determined their evaluations, how *HE*'s moral principles, goals and virtues factored into the debate, etc.

Another possible debate topic comes from the Asia Pacific regional report, which brings up considerations about the impacts of building hydroelectric dams in China. Assign your students to read the article, specifically looking for benefits and drawbacks of the dams. You can then assign two teams of about four people each to argue for the building of the dam (AFF) and against the building of the dam (NEG). Then lead the debate as outlined above.

*Asia Pacific:* Construction of dams is leading to severe habitat fragmentation in China.

Wendy Wright, a senior lecturer in biology and ecology, is studying the results of these changes on bird species. Read more [here](#).

### **Case Study Analysis**

These two case studies show how groups of people have responded to environmental issues in their communities. Have your students evaluate the ethics of these actions according to the following questions, adapted from *Christian Environmental Ethics: A Case Method Approach* by James Martin-Schramm and Robert Stivers:

1. *Action:* What issue were these communities trying to address? What alternative actions do you see as being possible in addition to what the community chose?
2. *Justification:* Which course of action do you think is morally preferable?
3. *Viability:* Do the people of this community have the power to act with the course of action that you chose?
4. *Strategy:* How do you think the community should put this plan into action? Would you change anything about their approach?
5. *Reflection:* How do you feel about the action steps that you chose?

*Africa:* The Great Green Wall is being designed to prevent further desertification of the Sahel region in Northern Africa. Learn about the progress being made on this [project](#).

*South America:* A report in *Science* magazine referenced in this National Geographic article suggests that over 33,000 square miles of forest have been preserved in Brazil since 2004. [Read more](#) about how farmers and ranchers have preserved biodiversity and reduced carbon emissions by decreasing deforestation.

#### **IV. Biodiversity and Spirituality**

*Shows the connection between biodiversity and environmental spirituality on the personal, local, and global levels.*

It is very important, here, that you have a clear understanding of the approach taken toward spirituality in *HE*. Spirituality will undoubtedly be the most challenging part of *HE* for teachers and students to accept as related to environmental science. It will be tempting to move through the topic quickly, or not at all. This would, however, degrade the very purpose of *HE*, which is to educate the *whole person* in environmental science. And spirituality is part of what makes up a whole person.

The difficulty is that most people immediately associate spirituality with either religion or some kind of mystical activity. The association of spirituality with religion is a problem for many people due to the history of some religions denying the results of science or intruding into the work of scientists. The association of spirituality with mystical activity is a problem for many people because, again, this activity seems completely unrelated or dismissive of science.

It is important that you help your students understand that spirituality is--in the first instance--a **constitutive feature of every human life**. Students need to understand that **all people have a spirituality--that they have a spirituality**. As stated in the Teacher Guide Introduction, *HE* begins with the view that spirituality is "the energy and content of beliefs that lie at the core of [every] human being's personal identity." This is why every Ethics Section in *HE* invites students to probe their fundamental thoughts and feelings about the natural world. This is an invitation to explore their 'inner spirit', or spirituality.

*HE* also relates spirituality to the particular experiences some people have of sensing a *sacred* quality in nature. Everyone has a spirituality in terms of an 'inner spirit', but not everyone experiences nature as something sacred. Additionally, *Healing Earth* relates spirituality to the beliefs and rituals of the world's religions, with a particular interest on beliefs and rituals concerning the natural world. Again, everyone has a spirituality in terms of an 'inner spirit', but not everyone's spirituality is linked to a religion.

With this in mind, the Spirituality Section of the Biodiversity chapter invites students to explore what biodiversity means to them, how people experience biodiversity as sacred, and how the world's religions treat biodiversity in their beliefs and rituals.

#### **Biodiversity and Personal Spirituality**

Give your students the following journal exercise, allowing them time inside or outside of class to complete it: Choose to place yourself in an area to which you are not accustomed.

Your goal is to observe a single species for 15 minutes. Remember that humans are also nature, so you may choose to visit a mall or a museum. Quietly observe this individual and imagine you are them. What are they thinking? What are they feeling? What are their needs? Attempt to calm your thinking about them, or any judgments you have about them or yourself. Just be them. Also experience what sensations arise in your body. Then, in your journal, write about what you experienced as this other species, what you thought, felt, needed — and what you would want humans to understand about you.

Coming back to yourself as a human, what would you say or do in response to the observed individual? Can you think of any ideas or possibilities of how you could, with others, perhaps, improve, protect, preserve, cherish, or otherwise meet the needs of the individual? Do any of these resonate with something that you would like to do?

### **Biodiversity and Sacred Experience**

Go back to the story in the Biodiversity Spirituality Section about the Mijikenda people of the Kaya Forest or the Indian women who started the Chipko Movement. Invite students to look into one or more of these examples of people who consider the diverse beauty of nature to be something 'sacred'. What do the people mean by that? Do students think it is possible for people in a modern, urban setting to see biodiversity as sacred?

### **Biodiversity and World Religions**

Have your students visit this [religion and biodiversity website](#) and choose one of the religious tradition's highlighted in the article. They can write an essay or short story inspired by the way that this faith tradition regards biodiversity.

### **Biodiversity Examen**

If your students are Catholic Christians you may want to lead them in a Jesuit Examen that focuses on biodiversity.

Ask your students to quiet themselves, close their eyes, and breathe deeply and calmly. Remind them that they are in the presence of God. Invite the students to take a moment in the silence of their hearts to ask the Holy Spirit to be with them in this Examen.

Ask them the following questions and pause for 30 seconds in between each:

When did you encounter diverse species of plants and animals today? While travelling to home or school? While eating? While interacting with other people or pets?

Do you ever feel grateful to God for the gift of Earth's biodiversity? Why or why not?

Have you done any damage to Earth's biodiversity today? Did you hurt another person or living thing? Ask for forgiveness from God for your shortcomings.

How could you better appreciate and support biodiversity in the future? Ask for the strength and knowledge to support biodiversity in ways that praise, reverence, and glorify God above all else.

Close by reciting the following Ignatian prayer of generosity: “Lord, teach me to be generous. Teach me to serve you as you deserve. To give and not to count the costs. To fight and not to heed the wounds. To toil and not to seek for rest. To labor and not to ask for reward, save that of knowing that I do your will. St. Ignatius, pray for us.”

**V. Biodiversity and Action**

*Gives awareness of biodiversity recovery actions taking place around the world and suggests personal actions students can take in their own communities.*

How can we use our scientific, ethical, and spiritual knowledge to act in ways that heal the planet? What is currently happening in various parts of the world to address the problem of declining biodiversity? Are there actions taking place in the students' communities that bear on the topic of biodiversity restoration? Are there actions that we take in our personal lives that help heal the Earth? These are the questions addressed in the Action Section.

**Actions in the World**

Take students through the Regional Reports (one for each continent) either individually or have them investigate these in groups and come back together to have a discussion. Make sure to draw connections between the each issue that we identified in the science section – evolution, keystone species, biological processes and resources, different biomes, invasive species, and anthropogenic activity.

Invite students to present actions or solutions to these problems. The website gives examples but make sure that students are given the chance to come up with their own solutions for their own communities. Look at actions that are taking place around the world – students could bring in current events to share with the class and discuss.

**Actions in the Community**

Some regions host preservation or restoration days to eliminate invasive species and plant native species instead. Is there a local group that your students could work with to set up a restoration day? Or could students restore your school grounds in similar ways?

**Personal Habits**

Connecting students directly to nature can shift their personal habits in regard to the world. Specifically, finding a way for your students to take care of a plant can help them recognize their responsibility for nature while rewarding the care they put into their plant. Find a

	<p>species of plant that is local to your region and relatively easy to maintain. Consider getting a plant for your classroom to care for collectively or having each of your students choose and care for a plant on their own, either at home or in the classroom. Growing plants from seeds can be a particularly illustrative activity if there is time to do so as a class. The need to monitor their plant regularly over long periods of time will teach your students about caring for our Earth as a whole.</p>
<p><b>VI. Reflection</b></p>	<p><i>Have students analyze their role in protecting Earth’s biodiversity and how they can take action based on these convictions.</i></p>
	<p>This is a chance to tie everything back together – science, ethics, spirituality, and action. By drawing all four of these aspects of the curriculum students should begin to understand the role they play in the planet Earth and why it is important for them to know all these aspects of the curriculum. Have them look back over all the work they have done and tie the different aspects together. This is where the concluding reflection questions should be brought in and students should be able to identify personal actions to alleviate the decreasing biodiversity.</p> <p>Any of the previous activities and explorations can encompass these lessons and values. The National Geographic website also has many resources for case studies and reflection activities that allow students to draw from each facet of the curriculum. For example, according to National Geographic, scientists have categorized nearly 2 million distinct species that live on our planet, although the total number of species estimated to exist is almost 9 million. <a href="#">Test your knowledge of biodiversity</a> by looking at a small sample of the many species of fungi, plants, birds, mammals, bacteria, and other organisms relying on a delicate balance of earth’s ecosystems for survival.</p> <p><b>Inspired Person</b></p> <p>Dr. Wangari Maathai founded the Green Belt Movement, a grassroots organization whose main focus is poverty reduction and environmental conservation through local tree planting. She received the 2004 Nobel Peace Prize for her fight to promote ecologically-viable social, economic, and cultural development in Kenya and in Africa. She embodies someone with a global perspective who acts locally to support biodiversity among many other social justice issues. Have your students look into Dr. Maathai’s story online. Some of her key speeches and articles can be found at <a href="http://www.greenbeltmovement.org/wangari-maathai/key-speeches-and-articles">www.greenbeltmovement.org/wangari-maathai/key-speeches-and-articles</a>.</p>

*Conclusion*

By the end of this chapter, students should have a deep scientific, ethical, and spiritual understanding of biodiversity by going through case studies, regional reports, identifying personal actions, and studying

the various biomes that are present on our planet. Important questions that students should be able to reflect on and answer by the end of this lesson are:

1. What two evolutionary processes are responsible for the development of biodiversity on Earth? How do these processes work to promote the emergence of new species? How long does it take for a new species to evolve?
2. How has the number of species changed over the past 550 million years? During what time periods have the five major extinction events taken place on the evolutionary timeline?
3. Name four categories of terrestrial biomes, and describe each biome's defining characteristics.
4. What are the four categories of ecosystem services? Describe three specific services provided by the ecosystem in which you live or one nearby your community.
5. What moral principles are necessary to consider when addressing Earth's declining biodiversity?
6. What ethical questions surface when the protection of property rights conflicts with the protection of Earth's biodiversity?
7. What is the relationship between biodiversity and sacred space?
8. In the Jewish and Christian religious traditions, what does biodiversity suggest about the characteristics of God?