

# Chapter 1 Environmental Science: Studying the State of Our Earth

## Chapter Summary

This chapter introduces the study of environmental science. It discusses key concepts used in the study of environmental science, including the systems perspective, environmental indicators, sustainability, and scientific method. The chapter establishes important foundations for chapters to come. The chapter consists of 3 modules:

- **Module 1:** Environmental Science
- **Module 2:** Environmental Indicators and Sustainability
- **Module 3:** Scientific Method

## Chapter Opening Case: *To Frack, Or Not to Frack*

The chapter opening case introduces you to the costs and benefits of using hydraulic fracturing, known as fracking, to extract oil and gas. This case demonstrates how human activities that are initially perceived as causing little harm to the environment can in fact have substantial adverse effects. It also illustrates the controversial side of issues that environmental scientists explore and the difficulty in obtaining absolute answers to environmental problems and questions.

## Do the Math

This chapter contains the following “Do the Math” boxes to help prepare you for calculation questions you might encounter on the exam.

- "Converting Between Hectares and Acres" (page 11)
- "Rates of Forest Clearing" (page 14)

To make sure you understand the concepts and techniques presented in these boxes, do the practice problems presented in the text as well as the additional "Practice the Math" problems that appear in Module 2 of this study guide.

# Module 1: Environmental Science

## BEFORE YOU READ THE MODULE

### Focus on Learning Objectives

Use the module learning objectives to guide your reading. On a separate piece of paper, write down each objective and take notes to help you meet each learning objective. After studying this module, you should be able to:

- define the field of environmental science and discuss its importance.
- identify ways in which humans have altered and continue to alter our environment.

### Preview Key Terms

In a notebook or on a separate sheet of paper, create a table like the one shown here to help with learning new key terms in the module. Before you read, fill out the "Prediction" column. Write what you think the term might mean or what it makes you think about. Use examples from your everyday life. There are no wrong answers!

Key Term	Prediction	Definition
<i>Write key term here.</i>	<i>Write what you think the term means in this column.</i>	<i>Define the term here. Add an example and use it in a sentence.</i>

### Key Terms

Fracking	Ecosystem	Environmentalism
Environment	Biotic	Environmental Studies
Environmental science	Abiotic	

## WHILE YOU READ THE MODULE

### Define Key Terms

When you come across a new key term while reading the module, copy the definition into the "Definition" column of your key terms table. Add an example and use the term in a sentence. Compare your initial ideas to the actual definition.

## Study the Figure

Examine Figure 1.2, “Systems within systems” on page 5. This figure demonstrates the complexity of environmental systems. Researchers can often define systems within systems, depending on the topic of study.

1. After studying this figure, describe a set of systems within systems in the area where you live or somewhere you have visited.

## AFTER YOU READ THE MODULE

### Review Key Terms

Match the key terms on the left with the definitions on the right.

- |                                |   |
|--------------------------------|---|
| _____ 1. Fracking              | a. Field of study that includes environmental science, environmental policy, economics, literature, and ethics                                  |
| _____ 2. Environment           | b. Living   |
| _____ 3. Environmental Science | c. Nonliving  |
| _____ 4. Ecosystem             | d. A person participates in environmentalism, a social movement that seeks to protect the environment through lobbying, activism, and education |
| _____ 5. Biotic                | e. A particular location on Earth distinguished by its mix of interacting biotic and abiotic components   |
| _____ 6. Abiotic               | f. The field of study that looks at interactions among human systems and those found in nature  |
| _____ 7. Environmentalist      | g. The sum of all the conditions surrounding us that influence life   |
| _____ 8. Environmental Studies | h. A method of oil and gas extraction that uses high-pressure fluids to open cracks in rocks deep underground                                   |

# Module 2: Environmental Indicators and Sustainability

## BEFORE YOU READ THE MODULE

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### Focus on Learning Objectives

Use the module learning objectives to guide your reading. On a separate piece of paper, write down each objective and take notes to help you meet each learning objective. After studying this module, you should be able to:

- identify key environmental indicators and their trends over time.
- define sustainability and explain how it can be measured using the ecological footprint.

### Preview Key Terms

In a notebook or on a separate sheet of paper, create a table like the one shown here to help with learning new key terms in the module. Before you read, fill out the "Prediction" column. Write what you think the term might mean or what it makes you think about. Use examples from your everyday life. There are no wrong answers!

Key Term	Prediction	Definition
<i>Write key term here.</i>	<i>Write what you think the term means in this column.</i>	<i>Define the term here. Add an example and use it in a sentence.</i>

### Key Terms

Ecosystem service  
Environmental indicator  
Biodiversity  
Genetic  
Diversity  
Species

Species  
diversity  
Speciation  
Background  
Extinction rate  
Greenhouse gases

Anthropogenic  
Development  
Sustainability  
Sustainable development  
Biophilia  
Ecological footprint

## **WHILE YOU READ THE MODULE**

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### **Define Key Terms**

When you come across a new key term while reading the module, copy the definition into the "Definition" column of your key terms table. Add an example and use the term in a sentence. Compare your initial ideas to the actual definition.

### **Study the Figure**

Use Figure 2.5, "Changes in average global temperature and in atmospheric CO<sub>2</sub> concentrations" on page 12 to answer the following questions:

1. According to the graph, what is the correlation between increased CO<sub>2</sub> levels and temperature over the past 100 years?
2. Determine approximate percent increase for carbon dioxide from 1800 to 1900 and from 1900 to 2000.
3. Compare your calculations from question 2. What is the correlation between atmospheric carbon and global temperatures?
4. Identify two possible human causes for the difference between the two centuries.

## Practice the Math: Converting Between Hectares and Acres

Read "Do the Math: Converting Between Hectares and Acres" on page 11. Try "Your Turn." For more math practice, do the following problems. Remember to show your work. Use a separate sheet of paper if necessary.

$$2.5 \text{ acres} = 1 \text{ hectare (ha)}$$

$$1 \text{ acre} = 0.40 \text{ ha}$$

Convert the following from acres to hectares.

$$50,000 \text{ acres} = \underline{\hspace{2cm}} \text{ hectares}$$

$$75,000 \text{ acres} = \underline{\hspace{2cm}} \text{ hectares}$$

$$150,000 \text{ acres} = \underline{\hspace{2cm}} \text{ hectares}$$

## Practice the Math: Rates of Forest Clearing

Read "Do the Math: Rates of Forest Clearing" on page 14. Try "Your Turn." For more math practice, do the following exercise. Remember to show your work. Use a separate sheet of paper if necessary. (1 acre = 0.40 ha)

Environmental organizations have yielded a range of estimates of the amount of forest clearing that is occurring in the Brazilian Amazon. Convert the first two estimates into hectares per day and compare the three estimates

- Estimate 1: 15 acre per minute
- Estimate 2: 22,000 acre per day
- Estimate 3: 8,000 ha per day

## AFTER YOU READ THE MODULE

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### Review Key Terms

Match the Key Terms on the left with the definitions on the right.

- |                                     |   |
|-------------------------------------|---|
| _____ 1. Ecosystem services         | a. The diversity of life forms in an environment  |
| _____ 2. Environmental indicator    | b. A measure of the genetic variation among individuals in a population   |
| _____ 3. Biodiversity               | c. Development that balances current human well-being and economic advancement with resource management for the benefit of future generations |
| _____ 4. Genetic diversity          | d. Love of life   |
| _____ 5. Species                    | e. Improvement in human well-being through economic advancement   |
| _____ 6. Species diversity          | f. An indicator that describes the current state of an environmental system   |
| _____ 7. Speciation                 | g. A group of organisms that is distinct from other groups in its morphology, behavior, or biochemical properties                             |
| _____ 8. Background extinction rate | h. Living on Earth in a way that allows humans to use its resources without depriving future generations of those resources                   |
| _____ 9. Greenhouse gasses          | i. A measure of how much an individual consumes, expressed in an area of land   |
| _____ 10. Anthropogenic             | j. The evolution of new species   |
| _____ 11. Development               | k. The number of species in a region or in a particular type of habitat   |
| _____ 12. Sustainability            | l. Derived from human activities  |
| _____ 13. Sustainable development   | m. The average rate at which species become extinct over the long term  |
| _____ 14. Biophilia                 | n. Gasses in Earth's atmosphere that trap heat near the surface   |
| _____ 15. Ecological footprint      | o. The processes by which life-supporting resources such as clean water, timber, fisheries, and agricultural crops are produced               |

# Module 3: Scientific Method

## BEFORE YOU READ THE MODULE

### Focus on Learning Objectives

Use the module learning objectives to guide your reading. On a separate piece of paper, write down each objective and take notes to help you meet each learning objective. After studying this module, you should be able to:

- explain the scientific method and its application to the study of environmental problems.
- describe some of the unique challenges and limitations of environmental science.

### Preview Key Terms

In a notebook or on a separate sheet of paper, create a table like the one shown here to help with learning new key terms in the module. Before you read, fill out the "Prediction" column. Write what you think the term might mean or what it makes you think about. Use examples from your everyday life. There are no wrong answers!

Key Term	Prediction	Definition
<i>Write key term here.</i>	<i>Write what you think the term means in this column.</i>	<i>Define the term here. Add an example and use it in a sentence.</i>

### Key Terms

Scientific method  
Hypothesis  
Null hypothesis  
Replication

Sample size ( $n$ )  
Accuracy  
Precision  
Uncertainty

Theory  
Control group  
Natural experiment

## WHILE YOU READ THE MODULE

### Define Key Terms

When you come across a new key term while reading the module, copy the definition into the "Definition" column of your key terms table. Add an example and use the term in a sentence. Compare your initial ideas to the actual definition.



## Study the Figure

Examine Figure 3.1, “The scientific method” on page 19. Complete this question in your notebook or on a separate sheet of paper.

1. An environmental science student conducting field observations noted dissolved oxygen levels in sunny areas of a lake were lower compared to dissolved oxygen levels recorded from shady areas of a lake. Use the flow chart in Figure 3.1 as a model to design an experiment to determine how temperature affects dissolved oxygen levels in an aquatic system. Include the following steps in your design:

- Observation and questioning
- Testable hypothesis
- Data collection procedure, including an experimental group and a control group
- Analysis of data, including a statement describing the importance of repeated trials (You may create sample data or simply describe the type of data to be collected.)

## AFTER YOU READ THE MODULE

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### Review Key Terms

Match the key terms on the left with the definitions on the right.

- |                            |  |
|----------------------------|--|
| _____ 1. Scientific method | a. A statement or idea that can be falsified, or proven wrong  |
| _____ 2. Hypothesis        | b. An objective method to explore the natural world, draw inferences from it, and predict the outcome of certain events, processes, or changes             |
| _____ 3. Null hypothesis   | c. An estimate of how much a measured or calculated value differs from a true value  |
| _____ 4. Replication       | d. The data collection procedure of taking repeated measurements   |
| _____ 5. Sample size       | e. A natural event that acts as an experimental treatment in an ecosystem  |
| _____ 6. Accuracy          | f. A hypothesis that has been repeatedly tested and confirmed by multiple groups of researchers and has reached wide acceptance                            |
| _____ 7. Precision         | g. In a scientific investigation, a group that experiences exactly the same conditions as the experiment group, except for the single variable under study |
| _____ 8. Uncertainty       | h. How close a measured value is to the actual or true value   |
| _____ 9. Theory            | i. The number of times a measurement is replicated in the data collection process  |

\_\_\_\_\_ 10. Control group

j. A testable theory or supposition about how something works

\_\_\_\_\_ 11. Natural experiment

k. How close the repeated measurements of a sample are to one another

## Chapter **1** Review Exercises

### Check Your Understanding

Review "Learning Objectives Revisited" on page 27 of your textbook. Compare the notes you took while reading each module. Complete these exercises to review the chapter.

1. What disciplines are incorporated into the study of environmental science?
2. List the 5 key global-scale environmental indicators.
3. Describe the following: genetic diversity, species diversity, and ecosystem diversity.
4. Give an example of an anthropogenic activity.
5. Currently, what is the size of the human population?
6. What is a person's ecological footprint?
7. List the steps in the scientific method.

## Practice for Free-Response Questions

Complete this exercise to build and practice the skills you will need to answer free-response questions on the exam. Use a separate sheet of paper if necessary.

Humans manipulate the environment more than any other species. Complete the table below to identify how human activities have affected the environment and to identify relevant environmental indicators that can help us evaluate the current state of the system.

<b>Human Activity</b>	<b>Environmental Impact</b>	<b>Environmental Indicator</b>
Increased numbers of human population		
Land use changes/ increased urbanization/ agriculture		
Increased rate of species extinctions		
Food production		
Burning fossil fuels		
Overfishing		

## Review and Reflect

Complete these activities to solidify your knowledge of the chapter concepts and key terms. Use a notebook or a separate sheet of paper if necessary.

1. Review your key terms table for each module.
  - (a) Which words did you already know? Which were new to you?
  - (b) Write a new sentence using each key term.
  - (c) Create a set of flash cards that includes each key term. Use the cards to review terms that were new or challenging.
  - (d) When you feel comfortable with the new or challenging terms, review all of the cards, including those with familiar terms.
  - (e) Save your cards to review before an exam.
  
2. What are the challenging concepts from this chapter?
  - (a) Identify any concepts you found particularly challenging in this chapter.
  - (b) Create a list of topics you need to review in preparation for an exam.
  
3. What questions do you have about concepts in the chapter?
  - (a) Note any further questions you might have about material in the chapter.
  - (b) Work with a partner to discuss these questions and ask your teacher for help as needed.
  
4. Write five possible multiple-choice questions based on this chapter. Work with a partner to quiz each other in preparation for an exam.