

6. What is net primary productivity and why do ecosystems depend on it? (10)
7. List and briefly describe Bouma-Prediger's Ten Reasons Why We Should Care for Creation. (20)
8. Summarize the biblical argument for creation care. (10)

First and Last Name _____

Environmental Science Quiz 13: Chapter 7 (7.1.1–7.2.1)

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. Identify and briefly describe each of Earth's atmospheric layers. (40)
2. Explain the idea that there is no place called "away." (30)
3. Explain some of the reasons why it is so easy to disconnect our actions from their consequences. (30)

First and Last Name _____

Environmental Science Quiz 14: Chapter 7 (7.2.4–7.3.7)

Point values for each item are shown in parentheses. Questions on this quiz may be answered with two to four sentences. Write all responses in complete sentences using correct spelling and grammar.

1. Distinguish between point and nonpoint sources of air pollution. (30)
2. Explain and give an example of externalized pollution costs. (30)
3. List the six major air pollutants. (40)

Environmental Science Chapter 7 Exam

Answer questions in complete sentences using correct spelling and grammar. Point values are shown in parentheses.

1. Explain how air-quality problems led to air-quality legislation. (10)
2. Explain the definition of justice and its opposite, injustice, in the context of environmental problems. (15)
3. List the six major air pollutants. (10)
4. Describe what acid rain is, its causes, and why it is harmful. (15)
5. Describe the history of human involvement addressing issues with the ozone layer. (15)

6. List and briefly explain Bouma-Prediger's Ten Reasons Why We Should Care for Creation. (15)

7. Explain why Earth has seasons. (10)

8. Explain the phrase "tragedy of the commons." (10)

Environmental Science

All Keys and Sample Answers



Thank you for using *Environmental Science*. This document contains sample answers to all questions in the text, on quizzes, and on exams.

The sample answers in this document are provided to aid in situations in which the adult teacher responsible for conducting the course does not possess a background in this subject, or in which a student is studying independently. The written answers provided here are only samples and should not be considered the only correct responses to the questions.

In environments where there are multiple students in a class or group, it is recommended that students form their own answers to chapter exercises in complete sentences as a homework assignment. These should be graded for completion only, not accuracy. Then in the group setting, students bring their preliminary answers to class where they collaborate with each other and the teacher to improve their answers. The final product is a useful study tool developed by the group. In such a setting, there is little need for the written answers in the present document, but it is provided for the many home study situations in which there is no collaborative group.

Additional information about how this course should be conducted is provided in the textbook introduction and in documents on the Digital Resources download. A full presentation of strategies and techniques for mastery-learning can be found in *From Wonder to Mastery*, available at classicalacademicpress.com.

Thank you!



Would you help make this document better? Send corrections to science@classicalsubjects.com.

There is an errata page at classicalacademicpress.com on the product page for this text under the Support tab.



Environmental Science: All Keys and Sample Answers

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Classical Academic Press

515 S. 32nd Street

Camp Hill, PA 17011

www.ClassicalAcademicPress.com/Novare/

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Chapter Exercises

Chapter 1 Exercises

SECTION 1.1

1. Explain the difference between material and immaterial things as they apply to science.

Science provides one way of knowing about our world. However, science is an excellent way of knowing some things and a poor way of knowing other things. Science can often describe material things, but many things of great value to us are immaterial, such as one's love for relatives or the best type of government to have.

2. The scientific method is usually described as beginning with observations. Describe non-observational ways to begin scientific research and include an example.

An important research approach, used by many scientists, is to work “backward,” starting with a problem or an idea (“I wonder if...”) and then using the scientific process to set up experiments that include observations. In such cases, the observations may address their research question by solving their problem or supporting the hypothesis. English epidemiologist and doctor John Snow offers a famous example of this “backward” approach. In 1849, he single-handedly stopped a deadly cholera epidemic in London. He did not first go and observe people in the streets of London looking for evidence of the disease. First, he wondered (hypothesized) whether cholera might be a water-borne disease rather than an airborne disease, as was commonly thought. He then mapped (observed) a high concentration of deaths surrounding one community water well on Broad Street. Further investigation confirmed the well was the cholera source. He correctly hypothesized that the disease was water-borne, the local government shut down the well, and the cholera epidemic stopped.

3. Explain the possible relationships between funding for research and the potential for biased results.

Research funding can come from a university, a government agency, private donors, non-profit organizations, and business. Funding can help focus the direction of research but if results are to be unbiased, then funding should not dictate results. Objective results—those not influenced by money—are more likely to come from universities and government agencies. In publications funded by commercial interests, the authors may have done terrific scientific work, but their funding makes the work suspicious. Bias, or the appearance of it, does occur with environmental non-profits too, but finances are less likely to sway the non-profit or their scientist. It is possible that a scientist working in a for-profit firm would expect a financial reward after research that is well received by the company.

4. List and describe the major sections of a typical scientific paper.

Scientific papers usually have five major sections: the abstract, the introduction, materials and methods, results, and discussion. Most start with an abstract and an introduction section that reviews previous research on the paper's topic. The materials and methods section explains in varying amounts of detail how the research was conducted. The results section displays text, charts, and figures that show the most important results, but not necessarily everything discovered. The discussion section usually compares the results with other work on the same or similar topics so that the significance of the results is explained. Few papers have a separate conclusion section; any concluding remarks are typically at the end of the discussion section.

5. Describe the peer-review process.

The editor, generally an expert in the scientific field addressed by the paper, initially accepts or rejects the paper, possibly allowing for resubmittal after revision. If accepted, the editor sends it out to two or three scientists who should be able to see the paper's good points and flaws. These scientists remain anonymous and the author hopes they will provide unbiased reviews. The reviewers' comments are made known to the editor and are passed on to the author, who then edits the paper based on the criticism received. It then goes back to the editor, who, at some point, either sends it back to the author yet again to make more changes or arranges for it to be proofed and sent to the publisher to appear in print or online within the next several months. This whole process is called peer review. It is a very thorough process, designed to eliminate errors, validate methods and claims, and produce a clear, focused, and accurate paper.

6. Why does a peer-reviewed paper have more legitimacy in the academic world than one that is not peer-reviewed?

It is important to remember that science is a human activity, and thus is subject to human failure. People, even scientists, make

mistakes. Sometimes even published articles must have corrections made. The best way to avoid these human errors is to have a good research plan and good peer review. Very rarely, a scientist errs by falsifying data or stealing information from others and then saying it is his or her own work. Researchers who show obvious bias that affects a study's results, publish sloppy work, or steal information can be demoted, fired, or publicly embarrassed by the organization they work for and then shunned by others in the field.

7. Name one advantage and one disadvantage of a scientist knowing a large amount about a narrow, specific topic.

They have literally spent years or even decades studying in their area, so they know more than just about anyone else. On the other hand, a lack of broader study may mean they are unable to see and appreciate the big picture.

8. Expand your answer to #3 above by using the U.S. Forest Service example presented in the chapter.

Sometimes even a government agency should be questioned rigorously. The author is skeptical of most forest research coming out of the U.S. Forest Service because it seems to him they have a long history of seeing forests as little more than standing timber waiting to be cut.

9. What kind of evidence would it take for the scientific world to accept as real the presence of Bigfoot?

Evidence that is treated to the rigor of peer review and published in a major, reputable scientific journal.

SECTION 1.2

10. Compare and contrast the two definitions of environmental science.

The first is that environmental science is an interdisciplinary study of the interactions between organisms and their physical surroundings, with an emphasis on addressing environmental issues that affect people (wastewater treatment, species reintroduction, smog reduction, creation of urban green spaces, elimination of neighborhood pollution, control of invasive species, etc.)

A second definition of environmental science is more restrictive and limits the field to the study of the physical environment and the organisms within it.

Both focus on organisms and their environment, but the first definition is more expansive in that it includes treatment of environmental issues that affect people.

11. What is the difference between environmental science and environmental studies?

The discipline of environmental studies combines the scientific study of environmental issues with established social science disciplines. Thus, environmental studies goes beyond the study of the environment itself and brings in consideration of issues associated with sociology, psychology, politics/policy/law, history, and economics.

12. What is environmentalism?

Environmentalism is a broad social and political movement that values protection of the planet and the people in it. It is a very big tent, with some individuals and organizations more focused on plants, animals, and ecosystems, and others more interested in environmental improvements that affect people. Environmentalists and environmental organizations may use both environmental scientists and those who practice within environmental studies to resolve environmental issues.

13. Name two ways that environmental organizations may be specialized.

Some focus on specific issues or organisms. Some groups are locally or regionally focused.

14. Why are some environmental groups' activities controversial?

Environmental groups are often involved in controversy due to their public education campaigns and political advocacy. Also, most groups work within the law, but others may break a minor law to gain publicity and support for their cause. These groups might start a protest downtown, stand in front of construction bulldozers, chain themselves to the main gate of an oil-company facility, videotape animal cruelty in meat-packing plants, or sit atop a tree to prevent it from being cut. Environmentalists are sometimes denigrated as lawless types, hippies, or tree huggers, but they have often pointed out that suit-and-tie business people and government agencies also sometimes ignore laws or regulations that they do not want to comply with. Also, there are a very few on the environmental side, who believe that the ends justify the means, and this sometimes translates into ac-

tions intended to damage property, and may put people in harm's way.

15. Are environmental organizations equally matched against their business or government opponents? Explain.

Environmentalists are often in David vs. Goliath situations, running on tight budgets, with few staff, against well-funded, well-staffed, politically powerful opponents. In a recent report, Giving USA estimates that \$16.14 billion, just 3% of U.S. charitable giving in 2021, went to the category described as Environment/Animals. Environmental groups often question the policies of government agencies in court, but it's tough taking on city hall, the county, the state, or the federal government. Governments have much larger budgets and can afford long, expensive litigation in the court system. The same situation occurs in conflicts between environmental groups and large businesses. The non-profit Citizen's Climate Lobby would like to wean the world off fossil fuels, but its entire budget for 2022 was \$1.37 million. A possible opponent, ExxonMobil oil company, made \$23 billion in profit in 2021 alone.

16. What sources of environmental research are usually accepted as objective and accurate?

Objective results—those not influenced by money—are more likely to come from universities and government agencies.

SECTION 1.3

17. Describe anthropocentrism and its position in society.

Anthropocentrism is the view that people always and at all times come first, so we are free to use creation to benefit ourselves regardless of all other considerations. Anthropocentrism is the dominant perspective in American society. It influences our politics, economics, and as noted above, even the way we express our faith.

18. How does the story about the goats of San Clemente Island illustrate biocentrism? Explain.

The goats were causing extensive harm to other species on the island. By far the cheapest method of reducing the goat population was aerial shooting by Navy sharpshooters. But the goats also had rights, emphasized by protesters, so the Navy went to the expense to round up or trap the goats and moved out through an adopt-a-goat program.

19. Contrast ecocentrism with biocentrism and explain the differences.

Biocentrism focuses on life only. The goal of ecocentric biologists is the functioning of an entire island's ecosystem—not individual animals. Ecocentrism's viewpoint is bigger than the individual species. Thus, ecocentrism is willing to sacrifice some animals if necessary to protect a larger ecosystem—the whole ecosystem is worth more than any of the individual parts.

20. Who is at the center of a theocentric viewpoint? What is the key question the theocentric position would ask?

God is at the center of the theocentric viewpoint. A theocentric viewpoint asks, "What does God have to say about how we should handle this?"

Chapter 2 Exercises

SECTION 2.1

1. Share two qualities of Dr. Calvin DeWitt that stand out to you and explain why.

Qualities described include:

- He is one of the original contemporary voices for connecting love of the environment and love of Christ, its creator.
- He has a great many achievements, such as helping to start both the Au Sable Institute of Environmental Studies and the Evangelical Environmental Network.
- He has decades of teaching experience.
- He has published a lot of books and papers.
- He helped establish ordinances that would permanently protect the Waubesa Marsh from encroaching development.
- He takes deep delight in the marvels of God's creation, and this blossomed into a desire to care for what God made.

SECTION 2.2

2. For the first seven of Steven Bouma-Prediger's Ten Reasons, give:

a. The secondary or descriptive title

b. A brief explanation of the reason

c. State whether this reason best fits with the anthropocentric, biocentric, ecocentric, or theocentric perspective.

i. If You Can Breathe, Thank a Tree

This is the self-interest argument. Reason 1 reminds us that it is in our self-interest to take care of the environment to avoid disease, suffering, and early death. This is an anthropocentric argument.

ii. On Loan from Our Children

This is the obligations-for-future-generations argument. This reason encourages us to use this planet sustainably so that future generations may also flourish. This argument is anthropocentric.

iii. 'Tis a Gift to be Simple

This is the joyful simplicity argument. While being simple still has an anthropocentric flavor, it also respects biocentric and ecocentric viewpoints and places value on individual life. It is a gift to the planet, and all the people, plants, and animals on it, to "live simply so that others may simply live." Simple living means we consume fewer resources and create less pollution. While being simple still has an anthropocentric flavor, it also respects biocentric and ecocentric viewpoints and places value on individual life and life systems.

iv. Poor and Oppressed Unite

This is the ecojustice argument. Environmental justice, or simply ecojustice, combines concern for justice for the powerless, a major biblical theme, with concern for equitable sharing of environmental costs. This argument still focuses on the environment as a resource for people and as such is essentially anthropocentric.

v. Spotted Owls Have Rights Too

This is the animal rights argument. Threatened or endangered animals and plants have legal rights in the U.S. due to the United States Endangered Species Act. In the U.S., we also have laws against animal cruelty. Since this reason focuses on organisms, it is biocentric.

vi. Value Generates Duty

This is the intrinsic-value argument. If we value something, then we have a duty to protect it so we can use it—a utilitarian ar-

gument. However, the flipside of utilitarianism is that little or no value is assigned to those things that are not of practical use by people. The value SB-P writes of is intrinsic value. The landscape, plant, animal, or river has value within itself, just because it exists. This reason says it doesn't matter that there are no uses for vernal pool fairy shrimp; they have intrinsic value simply because they exist. This is theocentric, but fails to mention the reason the value exists: From a theocentric viewpoint, rivers, plants, animals, and landscapes have value not because of how we might use them, but because of who made them.

vii. We Are All in This Together

This is the community-of-creation argument. We are literally and utterly dependent on the health of all the planet's ecosystems; there are none we can damage or destroy without hurting ourselves and the rest of God's creation. This is an ecocentric argument.

3. Address these questions pertaining to Reason #8, God Says So:

a. Has the planet we live on been cursed by God? Explain the difference between earth and Earth in your answer.

Faulty interpretation of these passages has created for some people the impression of a cursed planet that we should not bother to love or care for, but a much better interpretation is available. Regarding Genesis 3:17, the "ground," is cursed, not "earth" or "Earth." The word in Hebrew is *adamah*, from which Adam gets his name. Let's now look further at the term *adamah*, or "ground." An alternative way to look at Genesis 3:17 is that the ground was cursed to Adam. That would make more sense in a context where both the serpent and Eve are directly cursed, but Adam only indirectly. If the ground is cursed to Adam, then his toil and the thorns and thistles are seen to be part of a punishment that directly affects Adam.

b. Who does God make a covenant with as described after the flood in Genesis 9? Why does this matter?

In Genesis 9, God makes a covenant with Noah, with "every living creature," with "the earth," and with "all flesh." God places the rainbow in the clouds as a sign of this covenant. The "living creatures," "the earth," and "all flesh" are mentioned as partners in the covenant six times in this passage. Making a covenant requires a good relationship between parties. A covenant with "the earth" or "every living creature" would be a strange action to take if the planet and inhabitants are cursed. Thus, we conclude that we live in a good world created by a good God!

c. List all the living things that are told to be fruitful and multiply in Genesis 1.

In the garden, the command to be fruitful and multiply is given to people (v. 28) and to sea creatures and birds (v. 21, 22). Land animals are told to be fruitful after the flood in Genesis 8:15–17.

d. What are the two commands God gives Adam in Genesis 2:15? Are these two things done in equal parts?

In Genesis 2:15, God says that Adam's job is to work and keep the garden. A better translation—and one that helps us understand our obligations today—is "to serve and protect." Historically, people have focused on working the environment and not much on caring for it. Several factors contributed to this lop-sided focus, which is misaligned with God's intent in the garden. God intends that we use the environment to supply our needs, but that we also are diligent to protect it.

e. What does the word "keep" used in Genesis 2:15 mean?

A good translation is that it means to protect.

4. Address these questions pertaining to Reason #9, God's Concerns Are Our Concerns:

a. What is the secondary, descriptive title for this reason?

This is the image-of-God argument.

b. What does being made in the image of God entail?

In this context, being made in God's image means that God's concerns should be our concerns.

c. Summarize the three parts of the argument against Christian interest in creation care. For each part, write a counterargument based on Scripture.

Three ideas are used to defend the position that we need not care what happens to creation: the curse, the world not being our future home, and dominion.

Quizzes

Quiz 1 (Chapter 1)

1. Distinguish between environmental science and environmental studies.

Environmental science is the study of the interactions between organisms and their physical surroundings, with an emphasis on addressing environmental issues that affect people. Environmental studies combines the scientific study of environmental issues with established social science disciplines, and involves education, communication, planning, and other social areas.

2. Describe a common way in which bias can arise in publication of scientific research.

This can happen if research and publication are funded by for-profit corporations, leading to the expectation that the published research will favor the corporate business and profit.

Quiz 2 (Chapter 1)

1. Distinguish between environmental scientists and environmentalists.

Both groups may desire the same outcome but their approaches to achieving that goal may be different. While environmentalists are free to use science to study issues, they are also involved in advocacy, activism, and politics. Environmental scientists seek to preserve the credibility of their work, and must avoid even the appearance of bias and focus on the science.

2. List and describe in a short phrase four different points of view relating to how humans view the environment.

anthropocentrism: Human interests are the main or only focus; rights apply only to humans.

biocentrism: Life, in general, is the most important thing and organisms other than humans may have rights.

ecocentrism: Includes concern for the planet's ecosystems. Ecosystem functioning is what is important and central; the importance of an individual species is understood in terms of its role in the ecosystem.

theocentrism: Seeks to be God-centered. According to this view, all parts of creation are valuable because they are made by God. The Creator, and his purposes for creation, are at the center.

Quiz 3 (Chapter 2)

1. List Steven Bouma-Prediger's Ten Reasons to Care for Creation.

1. If You Can Breathe, Thank a Tree
2. On Loan from Our Children
3. 'Tis a Gift to Be Simple
4. Poor and Oppressed Unite
5. Spotted Owls Have Rights Too
6. Value Generates Duty
7. We Are All in This Together
8. God Says So
9. God's Concerns Are Our Concerns
10. "For the Beauty of the Earth"

Quiz 4 (Chapter 2)

1. List the first five of Bouma-Prediger's Ten Reasons to Care for Creation and write a sentence or two summarizing the main idea for each one.

1. If You Can Breathe, Thank a Tree:

We take care of the planet because it is necessary for our survival for us to do so.

2. On Loan from Our Children

Each generation is a temporary caretaker who passes on care for the Earth to the next generation. We should use this planet sustainably so that future generations may also flourish.

3. Tis a Gift to Be Simple

Simple living—the opposite of conspicuous consumption—means we consume fewer resources and create less pollution. This is an ethical position because in living simply we are making space for others to live as well.

4. Poor and Oppressed Unite

Environmental justice, or simply ecojustice, combines concern for justice for the powerless, a major biblical theme, with concern for equitable sharing of environmental costs. This argument recognizes that every person, regardless of wealth, skin color, or religion, has the right to an equal opportunity to enjoy a healthy environment.

5. Spotted Owls Have Rights Too

Under the Endangered Species Act, animals and plants that are threatened or endangered are given protection to help them rebound and survive. In other words, they are given rights. The recognition of the rights of other humans has been growing for decades, and now is being applied to animals and plants as well.

Quiz 5 (Chapter 3)

1. Why is systems thinking important in environmental science?

All systems have parts that interact with other parts and with other systems. Natural and human systems interact with each other, and environmental matters often involve several natural systems and the impact of human systems as well. Systems thinking helps us understand what happens for us and the rest of creation when we change our environment. There are almost always unforeseen consequences to our interactions with the environment around us.

2. Explain what a positive feedback loop is and give an example of one happening today in the environment.

A system or cycle that affects itself creates a feedback loop. Some systems and cycles have a tipping point that initiates a positive feedback loop—one that pushes the system forward. An example is ice and snow melting in the Arctic Ocean and Greenland. Warming temperatures melt highly reflective white snow and ice, exposing darker sea water and land, which absorb heat and create more melting, which exposes more dark sea water and land, and so on.

3. Name and briefly describe the four major Earth systems.

lithosphere—The outer shell of the Earth; all the solid ground we walk on, use for crops, mining for minerals, etc. Any variation in the lithosphere produces changes in the other spheres.

hydrosphere—All the water on the planet. Any variation in the hydrosphere produces changes in the other spheres.

atmosphere—The layer of gases surrounding Earth. All life depends on the atmosphere—animals breathe the oxygen and plants take in the carbon dioxide. The atmosphere also protects us from meteors and UV rays, cosmic rays, X-rays, and gamma rays.

biosphere—All the life on Earth.

Quiz 6 (Chapter 3)

1. Explain why Earth has seasons.

Earth's 23.5° tilt relative to its orbital plane exposes the surface to more or less solar energy as it orbits the Sun. This unequal exposure creates seasons: cold and short Northern Hemisphere winter days due to less sun, and hot and long summer days due to more sun. The Southern Hemisphere experiences the opposite of the Northern Hemisphere seasons.

2. Describe the major factors that determine the different terrestrial biomes.

Terrestrial biomes involve a combination of climate, geography, latitude, elevation, and prevailing wind direction. Climate depends on temperature and precipitation. Vegetation, a major part of biome descriptions, depends on climate; animals, in turn, depend on vegetation. Geography entails whether the location is hilly, mountainous, flat, rocky, and so on. Latitude and elevation determine the average temperature. The production of convection cells due to unequal heating and the Earth's rotation are the drivers that determine wind directions.

Quiz 7 (Chapter 4)

1. Explain the phrase “tragedy of the commons.”

The phrase “tragedy of the commons” is a metaphor for how what is given to all by God may be lost to all due to overuse. In early American history, the commons was land on the outskirts of the village that was available to all as pasture for livestock and horses. Given free pasture, there is a temptation for individuals to put more and more livestock on the commons. But if all the villagers do so, the commons will deteriorate and be of no use to anyone—that is the tragedy.

2. Explain ecosystem diversity and distinguish it from species biodiversity and genetic diversity.

Ecosystem diversity is associated areas that have a diverse physical environment—a mixture of mountains, plains, waterways and so on. A great biodiversity of ecosystems correlates to a diversity of species.

Genetic diversity refers to the small differences at the genetic level that make individual members of a species different.

Species biodiversity usually refers to species richness—the number of species in an ecosystem. Species biodiversity is a sign of ecosystem health.

Quiz 8 (Chapter 4)

1. Summarize current biodiversity status in plants, marine species, terrestrial invertebrates, birds, mammals, amphibians, and reptiles.

Plants: Globally, it is estimated that approximately 40% of plants and fungi are endangered and headed toward extinction.

Marine Species: This is hard to estimate because of lack of data. But an indicator is that in 2020, the IUCN said 25% of marine mammals are critically endangered, endangered, or vulnerable.

Terrestrial Invertebrates: This category is data deficient. But an indicator is monarch butterflies. The western population has declined by an estimated 99.9% in 40 years; the larger eastern population shrank by 84%. Another indicator is molluscs: a large number of mollusc species have already gone extinct.

Birds: Both the numbers of birds and the number of bird species are declining. One study estimates we have about 100 billion birds on the planet, but that is one fifth to one fourth of what populations were before the emergence of industrial agriculture. A study in 2019 documented heavy losses of common birds over many North American biomes. We now have 29% of the population of birds we had in 1970.

Mammals: Over 20% of mammal species are threatened and 85 are extinct.

Amphibians: The number of threatened species is in the mid-thirties.

Reptiles: About 32 species are threatened. Most of the turtles are threatened.

Chapter Exams

Exam 1

1. Distinguish between environmental science, environmental studies, and environmentalism.

Environmental science is the study of the interactions between organisms and their physical surroundings, with an emphasis on addressing environmental issues that affect people. Environmental studies combines the scientific study of environmental issues with established social science disciplines, and involves education, communication, social justice advocacy, planning, and other areas of social concern.

Those engaged in environmentalism are mainly involved in advocacy, activism, and politics. They are free to use science to study issues.

Environmental scientists focus on the science and typically avoid activism and politics because they seek to preserve the credibility of their work, and must avoid the possibility of appearing biased.

2. Describe how bias can arise in scientific research and why it should be avoided.

This can happen if research and publication are funded by for-profit corporations, leading to the expectation that the published research will favor the corporate business and profit. It should be avoided so that scientific research is unbiased and thus neutral, objective, and fair. Policy makers and legislators require objective, unbiased information so that laws and policies are fair for everyone.

3. What is peer review in scientific publishing and why is it used by credible journals?

When a journal editor accepts a paper for publication, the editor sends it out for peer review. In this process, the paper is sent to two or three scientists who should be able to see the paper's good points and flaws. These scientists remain anonymous and the author hopes they will provide unbiased reviews. The reviewers' comments are made known to the editor and are passed on to the author, who then edits the paper based on the criticism received. It then goes back to the editor, who, at some point, either sends it back to the author yet again to make more changes or arranges for it to be proofed and published. The peer-review process is very thorough, and is designed to eliminate errors, validate methods and claims, and produce a clear, focused, and accurate paper.

4. Describe, with examples, two reasons why all supposedly scientific publications are not equally credible.

The first is if bias may be present. A study on forest management paid for by the lumber industry is more likely to contain conclusions that favor the lumber industry.

The second is if the publication has little history or is maintained by a fringe group, outside the scientific mainstream.

A third would be if the publication does not make use of the peer-review process.

5. List and describe four different points of view relating to how humans view the environment.

anthropocentrism: Human interests are the main or only focus; rights apply only to humans, so we are free to use creation to benefit ourselves regardless of all other considerations. A related view is utilitarianism, which is the view that entities in creation only have value if they have cash value for humans.

biocentrism: Life, in general, is the most important thing. All life has rights, and some of those rights might be equal to ours.

ecocentrism: Includes concern for the planet's ecosystems. Ecosystem functioning is what is important and central; the importance of an individual species is understood in terms of its role in the ecosystem, and there may be times when an individual species must be eradicated from an area for the health of the overall ecosystem. Under this view, even non-living things such as rivers or mountains may be accorded rights.

theocentrism: Seeks to be God-centered. According to this view, all parts of creation are valuable because they are made by God. The Creator, and his purposes for creation, are at the center. The self-interest of anthropocentrism disappears because people are not at the center of the universe. Theocentrism agrees with biocentrism that every life is of value because every life

is made, sustained, and cherished by God. Theocentrism agrees with ecocentrism that the entire environment is important as well because God made the whole world and cares about how all of it functions together in proper balance.

Exam 2

1. List and explain the Ten Reasons Why We Should Care for Creation.

1. If You Can Breathe, Thank a Tree:

We take care of the planet because it is necessary for our survival for us to do so.

2. On Loan from Our Children

Each generation is a temporary caretaker who passes on care for the Earth to the next generation. We should use this planet sustainably so that future generations may also flourish.

3. Tis a Gift to Be Simple

Simple living—the opposite of conspicuous consumption—means we consume fewer resources and create less pollution. This is an ethical position because in living simply we are making space for others to live as well.

4. Poor and Oppressed Unite

Environmental justice, or simply ecojustice, combines concern for justice for the powerless, a major biblical theme, with concern for equitable sharing of environmental costs. This argument recognizes that every person, regardless of wealth, skin color, or religion, has the right to an equal opportunity to enjoy a healthy environment.

5. Spotted Owls Have Rights Too

Under the Endangered Species Act, animals and plants that are threatened or endangered are given protection to help them rebound and survive. In other words, they are given rights. The recognition of the rights of other humans has been growing for decades, and now is being applied to animals and plants as well.

6. Value Generates Duty

This refers to the intrinsic value of everything in creation. The landscape, plant, animal, or river has value within itself, just because it exists. It doesn't matter that there are no uses for certain canyons, species, or pools of water; they have intrinsic value simply because they exist.

7. We Are All in This Together

Ecology shows us how completely dependent we are on the other species and non-living parts of creation: we depend on plants and animals for food, on billions of bacteria to help us digest our food, on trillions more to process our waste at sewer plants, and on the air and water we require to survive. In recent decades, research has revealed that everything about our bodies relies on the bacteria in us and on us. Plants, on whom we are utterly dependent for food and many medicines, also depend on the millions of microorganisms in the soil. We are literally and utterly dependent on the health of all the planet's ecosystems; there are none we can damage or destroy without hurting ourselves and the rest of God's creation.

8. God Says So

In Genesis 2:15, God also says that Adam's job is to work and care for the garden. The best translation—and one that helps us understand our obligations today—is “to serve and protect.” Humanity's first work assignment was to cultivate a garden—which meant to feed ourselves! Today, just as Adam was placed in the garden, we are placed into the ecosystems where we live. Like Adam, we must work and gather resources from our environment to live, and we must serve and protect the environment while we are at it.

9. God's Concerns Are Our Concerns

We are made in God's image, and God's concerns should be our concerns. We must cherish and sustain it because God does. This is what the concept of stewardship is all about. As those made in God's image, we are God's stewards, and stewardship of creation should be one of our highest concerns.

10. “For the Beauty of the Earth”

We should care for the creation because it is beautiful, it sustains us, it amazes us, it awes us—and all this beauty is freely given for our use and care.

2. Demonstrate, using biblical references, why the three ideas of the Genesis curse, the Earth not being our home, and dominion do not give humans license to be indifferent toward creation care.

On the curse: In Genesis 8:21 God says “I will never again curse the ground because of man.” In Genesis 9, God makes a covenant with Noah, with every living creature, with the earth, and with all flesh. A covenant with the earth or every living creature is inconsistent with the idea that the planet is cursed. Thus, in Genesis 3:17 the ground was cursed to Adam but not generally. We live in a good world created by a good God.

On the Earth as our home: Romans 8 states that “the creation waits with eager longing for the revealing of the sons of God” and “the creation itself will be set free from its bondage to corruption and obtain the freedom of the glory of the children of God.” The verses speak of renewal and redemption, not destruction. Thus, God intends to redeem the Earth as well as us and the Earth will be part of our future.

On dominion: Psalm 24 says “The earth is the Lord’s and the fullness thereof.” The Earth was not “given to man” for him to wantonly exploit it. Human dominion is about loving good stewardship and is not a license to do as we wish with God’s creation.

3. State the key New Testament verses in John, Colossians, and Hebrews informing us of Christ’s role in creation.

John 1:3. All things were made through him [Christ], and without him was not anything made that was made.

Colossians 1:16, 17. For by him [Christ] all things were created, in heaven and on earth, visible and invisible, whether thrones or dominions or rulers or authorities—all things were created through him and for him. And he is before all things, and in him all things hold together.

Hebrews 1:2. But in these last days he has spoken to us by his Son, whom he appointed the heir of all things, through whom also he created the world.

4. Describe ways in which environmental science is interdisciplinary.

Environmental science is interdisciplinary because it involves life sciences, physical sciences, atmospheric sciences, and Earth sciences. Because people are often the cause of environmental problems, environmental science also involves disciplines related to people: education, sociology, psychology, political science, history, and economics.

5. Explain the significance for creation care of passages—such as Psalm 19, Psalm 148, and Romans 1—that describe all of creation as declaring God’s glory, praising him, and teaching us of him.

These passages testify to God’s relationship with creation. If God didn’t care about creation, these passages would be meaningless. The only conceivable reason these praises are encouraged and meaningful is because God loves, cherishes, and cares for the source of these praises.

6. Explain the ancient theological understanding that God is known through two books of revelation, his Word and his Works.

The two books of revelation are regarded as General Revelation, that is, revelation to us from the creation (God’s works), and Special Revelation, which is the Scripture, the written word that testifies about Jesus Christ as the Son of God our Savior. Romans 1:20 explicitly affirms General Revelation: “For his [God’s] invisible attributes, namely his eternal power and divine nature, have been clearly perceived, ever since the creation of the world, in the things that have been made.”

7. What is utilitarianism and how does it fit in with the four major perspectives on how humans relate to the environment?

Utilitarianism is the view that entities in creation only have value if they have cash value for humans. This means that utilitarianism is part of the anthropocentric perspective, where human interests are the main or only focus; rights apply only to humans, so we are free to use creation to benefit ourselves regardless of all other considerations.

8. Why would an environmental scientist carefully refrain from political activism?

If an environmental scientist engages in activism, he or she could easily be taken for someone with a particular bias or agenda. This might seem to compromise the objectivity of his or her scientific research, resulting in loss of research or publication opportunities. Environmental scientists must stick to the science.

Exam 3

1. Explain the vegetative base of a terrestrial biome and the abiotic components that create it.

Vegetation is at the core of the descriptions of various biomes. Vegetation depends on climate; animals, in turn, depend on vegetation. Climate depends on temperature and precipitation. Other factors affecting terrestrial biomes are geography, latitude, elevation, and prevailing wind direction. Geography entails whether the location is hilly, mountainous, flat, rocky, and so on. Latitude and elevation determine the average temperature. The production of convection cells due to unequal heating and the Earth's rotation are the drivers that determine wind directions.

2. Name two specific examples of links between terrestrial and marine biomes.

Answers will vary. Examples:

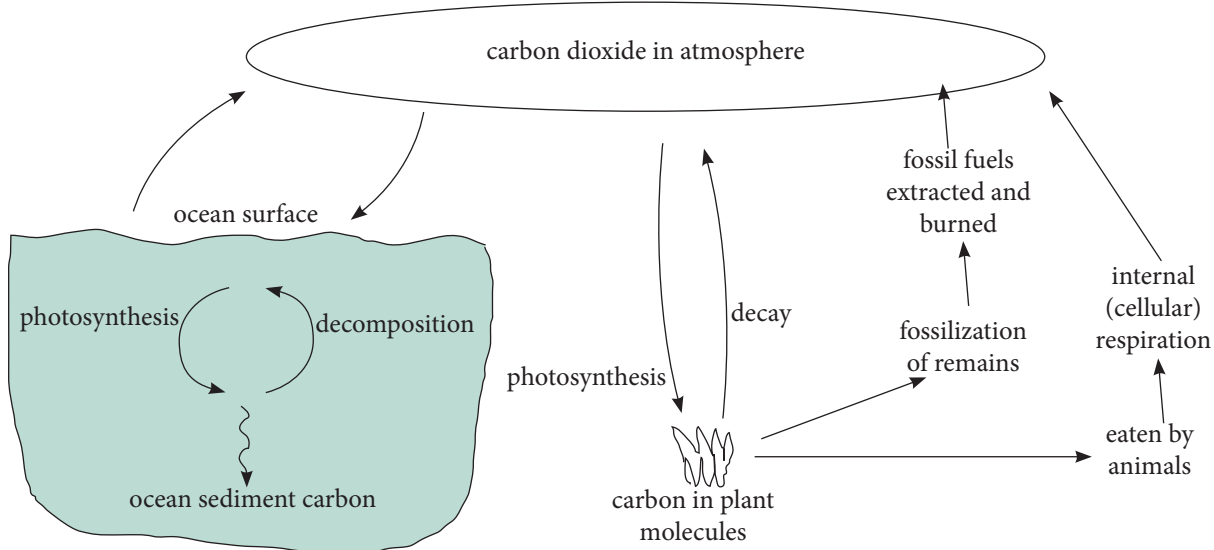
Silt from land washing into marine environments.

Carbon from dead organisms washing into marine environments.

Minerals such as dissolved nitrogen, phosphorus, and salts are washed into oceans and affect the water chemistry.

The sea affects terrestrial biomes too. The ocean provides salt for terrestrial biomes. Salt is a necessary trace mineral for many animals. Salt is put into the coastal air by crashing waves and wafts inland many miles.

3. Draw a diagram illustrating the carbon cycle, including how human activity is affecting it.



4. Briefly describe the various oceanic zones that support life.

The littoral zone is the coastal area, consisting of kelp, sea-grass beds, tide pools, and beaches. They are beaten by surface waves. Life in tide pools and beaches is subject to tides that flood them or leave them dry. Tide-pool salinity and temperature vary widely because of evaporation, rainfall, and cold or hot weather. Sunlight floods everything and warms the water. Large numbers of tiny plants and animals, the plankton, live near the top of the water. They occur with countless bacteria and viruses, which interact with the plankton and other life.

From the surface down to 200 m depth is the photic zone—the entire zone that the Sun's light penetrates. It is home to most of the ocean's life. Most fishing occurs in this zone since many fish prefer the abundance of food there.

The entire free-swimming area is the pelagic region. Light penetrates down to 200 m, and diminishes rapidly below that. Below this photic zone are zones called epipelagic, mesopelagic, bathypelagic, abyssopelagic, and hadalpelagic.

At the bottom of the continental slope is either an abyssal plain or a trench. The abyssal plains are flat, dark, and vast. Still deeper are trenches, located above subduction zones of Earth's tectonic plates. The abyssal plains and trenches are in the aphotic zone (no light), so life that exists at this level depends on the rain of organic material falling from above.

Hydrothermal vents are usually associated with midoceanic ridges. Plumes of hot magma come up from the Earth's mantle and spread apart at the ridge. This pushes the ridge apart and creates sites where seawater seeps into the area and then is spewed forth, rich in minerals that are lacking at that depth. Water escaping the vents reaches 371°C but does not boil due to the immense pressure. An amazing variety of animals lives besides these vents: mussels, crabs, tubeworms, gastropods, shrimp, and various bacteria. There is a complete absence of light at these depths, so the ecosystem depends on chemosynthesis, rather than photosynthesis.

5. Describe an example of the interaction between a natural system and a human system.

Answers will vary. Example:

Automobile transportation powered by gasoline is a human system that releases a great deal of carbon dioxide in the atmosphere, a natural system. Since carbon dioxide is a greenhouse gas, the increase has caused an increase in global average temperature.

6. What is net primary productivity and why do ecosystems depend on it?

Net primary productivity (NPP) is the amount of chemical potential energy plants produce, mostly by photosynthesis, minus the amount of chemical potential energy plants use up during cellular respiration. Ecosystems depend on it because the NPP is the biomass that provides the energy for all primary consumers and some secondary consumers—the organisms that eat plants.

7. List and briefly describe Bouma-Prediger's Ten Reasons Why We Should Care for Creation.

1. If You Can Breathe, Thank a Tree:

We take care of the planet because it is necessary for our survival for us to do so.

2. On Loan from Our Children

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3. Tis a Gift to Be Simple

Simple living—the opposite of conspicuous consumption—means we consume fewer resources and create less pollution. This is an ethical position because in living simply we are making space for others to live as well.

4. Poor and Oppressed Unite

Environmental justice, or simply ecojustice, combines concern for justice for the powerless, a major biblical theme, with concern for equitable sharing of environmental costs. This argument recognizes that every person, regardless of wealth, skin color, or religion, has the right to an equal opportunity to enjoy a healthy environment.

5. Spotted Owls Have Rights Too

Under the Endangered Species Act, animals and plants that are threatened or endangered are given protection to help them rebound and survive. The recognition of the rights of other humans has been growing for decades, and now is being applied to animals and plants as well.

6. Value Generates Duty

This refers to the intrinsic value of everything in creation. The landscape, plant, animal, or river has value within itself, just because it exists.

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We are completely dependent on the other species and non-living parts of creation. Everything about our bodies relies on the bacteria in us and on us. Plants, on whom we are utterly dependent for food and many medicines, also depend on the millions of microorganisms in the soil. Since we are dependent on the health of all the planet's ecosystems; there are none we can damage or destroy without hurting ourselves and the rest of God's creation.

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10. "For the Beauty of the Earth"

We should care for the creation because it is beautiful, it sustains us, it amazes us, it awes us—and all this beauty is freely given for our use and care.

8. Summarize the biblical argument for creation care.

This is summarized by points 8 and 9 above.

First, God commanded Adam to serve and protect the garden, a commission that applies to us generally. Second, many scriptures highlight God's care for and love for creation, and as people made in God's image, God's concerns should be our concerns. This means we are stewards of his creation.

Additionally, all of creation praises the Lord (Psalms 148, 150), and we should protect that chorus of praise and help it to flourish.

Exam 4

1. List five benefits resulting from healthy ecosystems.

Answers will vary since many more than five are given in the text. Examples:

When ecosystems are working well, there is plenty of clean air produced by plants.

When ecosystems are working well, there is plenty of food.

When ecosystems are working well, there is plenty of clean water.

When ecosystems are working well, the climate is stable.

When ecosystems are working well, some materials can be harvested and the ecosystem replaces them.

When ecosystems are working well, the surroundings are beautiful and scenic.

When ecosystems are working well, nature is appreciated by humans and becomes part of culture.

When ecosystems are working well, natural hazards are known.

When ecosystems are working well, high-quality public health can be maintained.

When ecosystems are working well, local and regional economies can work well too.

20. Name the largest issue that is producing a shift from fossil fuels to renewable fuels, and state other reasons why a nation might want to switch to renewable fuels.

The biggest reason is climate change—everyone wants to get off burning fossil fuels because it produces so much carbon dioxide. Other reasons are

- energy independence—Countries may not want to depend on oil-producing countries for the fuel needed for electricity.
- jobs—Lots of jobs are produced by the new green economy.
- environmental protection—Countries may want to avoid potential oil spills from oil tankers.
- avoiding mining—countries may want to move away from coal mining because of the health hazards associated with mining.
- cleaner air—In addition to carbon dioxide, burning coal produces toxic emissions from sulfur, mercury, and other heavy metals that countries wish to avoid.

Spring Semester Exam

1. List and briefly explain Bouma-Prediger's Ten Reasons Why We Should Care for Creation.**1. If You Can Breathe, Thank a Tree:**

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8. God Says So

Course Lesson List Environmental Science Fall Semester

Lesson Number	Activity or Topic	Text Key	Assignment	Notes
1	Opening day: Review syllabus and how to study for mastery by practicing.			
2	Scientists and Their Professional World	1.1	1.1 exercises	
3	Environmental Science, Environmental Studies, and Environmentalism	1.2.1-1.2.3		
4	ACEnS Activity 1: Dandelions and Hula Hoops			ACEnS = <i>The Apprentice's Companion for Advanced Biology</i> , available from Novare Science and Classical Academic Press
5	Quiz 1 (1.1.1-1.2.3) Environmentalism	1.2.4, 1.2.5	1.2 exercises	Quiz 1
6	Different Lenses Change the Optics	1.3	1.3 Exercises	
7	ACEnS Activity 2: Backyard Biodiversity			This is the first day of work on this activity.
8	Quiz 2 (1.2.4–1.3) Chapter summary/review			Quiz 2
9	Exam Chapter 1			Exam Chapter 1
10	Why Should I Care? Ten Reasons to Care	2.1-2.2.3		
11	Ten Reasons to Care	2.2.4-2.2.5		
12	Quiz 3 (2.2) Ten Reasons to Care	2.2.6		Quiz 3
13	Ten Reasons to Care	2.2.7	2.2 exercises (begin)	
14	ACEnS Activity 3: Food Webs and Stewardship			
15	Ten Reasons to Care	2.2.8		
16	Ten Reasons to Care	2.2.8-2.2.10		
17	ACEnS Activity 4: Fish Story			
18	Quiz 4 (2.2.1–2.2.10) Ten Reasons to Care	2.11-2.12	2.2 exercises Review Questions	Quiz 4
19	Discussion			
20	Discussion			
21	Exam Chapter 2			Exam Chapter 2
22	Introduction to Systems	3.1	3.1 exercises	
23	Earth Systems	3.2.1		
24	Ecosystems	3.2.2	3.2 exercises	
25	Quiz 5 (3.1.1-3.2.1) Terrestrial Biomes	3.3.1-3.3.2		Quiz 5
26	Climate and Biomes Major World Biomes	3.3.4-3.3.5	3.3 exercises	
27	ACEnS Activity 5: Climate and Biomes			
28	ACEnS Activity 6: What Will Transpire			This is the first day of work on this activity.
29	Aquatic Biomes	3.4	3.4 exercises	
30	Elemental Cycles and Life	3.5	3.5 exercises	
31	Quiz 6 (3.3.1–3.3.4) Biological Energy Flows	3.6	3.6 exercises Review Questions	Quiz 6
32	ACEnS Activity 7: Algae Adventures			This is the first day of work on this activity.
33	Discussion			
34	Exam Chapter 3			Exam Chapter 3
35	Ecosystem Services and Valuation	4.1	4.1 exercises	
36	Introduction to Biodiversity	4.2	4.2 exercises	
37	Human Impact on Biodiversity	4.3		
38	Quiz 7 (4.1–4.2) Human Impact on Biodiversity	4.3		Quiz 7
39	Human Impact on Biodiversity	4.3	4.3 exercises	
40	ACEnS Activity 8: Bean-Bag Biogeography			
41	Natural Disruptions	4.4	4.4 exercises	
42	Quiz 8 (4.3) Ecological Tolerance	4.5	4.5 exercises	Quiz 8
43	ACEnS Activity 9 Living Waters			This is the first day of work on this activity.
44	Islands, Endangered Species Act	4.6-4.7	4.5-4.6 exercises	
45	Restoration Ecology	4.8	4.8 exercises Review Questions	
46	ACEnS Activity 10 Squirrels and Oaks			
47	Discussion			
48	Chapter 4 Exam			Chapter 4 Exam
49	Human Population	5.1	5.1 exercises	
50	Limiting Factors	5.2	5.2 exercises	
51	ACEnS Activity 11: Nest Predators			
52	Quiz 9 (5.1.2–5.2.3) Future Human Population Growth	5.3	5.3 exercises	Quiz 9
53	Characterizing Populations	5.4	5.4 exercises	
54	Global Population and Development	5.5	5.5 exercises	

55	ACEnS Activity 12: Bubble Survivorship			
56	Our Family and Yours	5.6	5.6 exercises Review Exercises	
57	Quiz 10 (5.2.4–5.3) Discussion			Quiz 10
58	ACEnS Activity 13: Grave Consequences			Field trip.
59	Discussion			
60	Chapter 5 Exam			Chapter 5 Exam
61	Renewable and Nonrenewable Energy Resources	6.1	6.1 exercises	
62	Nonrenewable Energy Resources	6.2	6.2 exercises	
63	Quiz 11 (6.1–6.2.1) ACEnS Activity 14: Power Trip			Quiz 11 This is a brief info session to get students going on Activity 14. Longer session for calculations occurs later.
64	Renewable Energy Resources	6.3	6.3 exercises	
65	Renewable Energy Resources	6.3	6.3 exercises	
66	ACEnS Activity 15: Here Comes the Sun			Make the cooker one day, cook s'mores the next day so class can continue during cooking.
67	Quiz 12 (6.2.2–6.3.3 Global Energy Use	6.4	6.4 exercises	Quiz 12
68	ACEnS Activity 16: Oil and Trouble			
69	Energy in the United States	6.5	6.5 exercises Review Questions	
70	Discussion			
71	ACEnS Activity 14: Power Trip			This is the day for working on calculations.
72	Discussion			
73	Chapter 6 Exam			Chapter 6 Exam

Citations and References
for
Environmental Science: Caring for the Creator's World
by
Mark and Karen McReynolds
Novare Science, 2025

Chapter 1

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Chapter 3

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