
IDIOT'S GUIDES
AS EASY AS IT GETS!
Environmental Science
An in-depth look at Earth's ecosystems and diverse inhabitants
The history and impact of major ecological movements
Straightforward explanations of complex environmental issues
James Dauray, MEd

No one likes a know-it-all. Most of us realize there's no such thing—how could there be? The world far too complicated for someone to understand *everything* there is to know. So when you come across a know-it-all, you smile to yourself as they ramble on because you know better.

You understand that the quest for knowledge is a never-ending one, and you're okay with that. You have no desire to know everything, just the *next* thing. You know what you don't know, you're confident enough to admit it, and you're motivated to do something about it.

At *Idiot's Guides*, we, too, know what we don't know, and we make it our business to find out. We find really smart people who are experts in their fields and then we roll up our sleeves and get to work asking lots of questions and thinking long and hard about how best to pass along their knowledge to you in the easiest, most-accessible way possible.

After all, that's our promise—to make whatever you want to learn "As Easy as It Gets." That means giving you a well-organized design that seamlessly and effortlessly guides you from page to page, topic to topic. It means controlling the pace you're asked to absorb new information—not too much at once but just what you need to know right now. It means giving you a clear progression from easy to more difficult. It means giving you more instructional steps wherever necessary to really explain the details. And it means giving you fewer words and more illustrations wherever it's better to show rather than tell.

So here you are, at the start of something new. The next chapter in your quest. It can be an intimidating place to be, but you've been here before and so have we. Clear your mind and turn the page. By the end of this book, you won't be a know-it-all, but your world will be a little less complicated than it was before. And we'll be sure your journey is as easy as it gets.

Mike Sanders
Publisher, *Idiot's Guides*

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Environmental Science

by James Dauray, MEd

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Contents

Introduction

This book is designed to give you a primer on some of the most important concepts and issues in a very diverse, complex, and multifaceted field: environmental science.

Environmental science is a multidisciplinary study. There are a lot of concepts from many different fields you'll need to know in order to begin unraveling some of the big issues that face our society today. In this book, we'll explore lessons we've learned from past mistakes, current controversies being debated, and some of the future implications of our choices.

How This Book Is Organized

Part 1, The Basics of Environmental Science, is designed to provide the most fundamental concept the reader needs to fully appreciate and understand the ideas presented throughout the rest of the boo This part contains general science background that's relevant to environmental science, which is itse an interdisciplinary science.

Part 2, The Biosphere, explores the vast diversity of life and resources present on Earth. The reader will learn about the different types of species, how they evolved, why they look the way they do, and where they live. This part makes relatively little mention of human effects—that's for later, as the second half of the book explores the different ways these ecosystems and resources have been change by human growth and needs.

Part 3, Meeting Human Needs, begins the gradual introduction of human influences on the ecosystems, species, and resources throughout the world. We begin by examining human population growth, projections of our growth, and how this growth varies from country to country. The focus the moves to human needs and human health, beginning with an overview of the food production system and ending with the different living and nonliving components in the environment that can be detrimental to human health.

Part 4, A Look at Energy, covers fossil fuels, alternative sources, and renewable, sustainable energy Production of electricity, fuel, and heating gas is one of the single largest sources of environmental degradation discussed throughout the rest of the book. In other words, this is the "source of all evil" when it comes to many environmental issues.

Part 5, Consequences, looks at some of the hidden prices we pay for our level of consumption and th resources needed to support our population. These impacts are divided into air and water pollution, with the global climate change chapters directly following air pollution (since it's a direct result of carbon dioxide emissions).

Part 6, Hope for the Future, discusses specific changes and technologies that are vital to the human population finding a way to live on Earth sustainably. Many of the concepts from throughout the boo will circle back here as we look for solutions.

Extras

Within each chapter, there are a few different types of sidebars to highlight some important events, definitions, or even relevant quotes that highlight what we're discussing.

DEFINITION

These sidebars explain significant and possibly unfamiliar terms that are referenced in the section. These are important ideas to know and understand to make sense of the bigger concepts in the chapter.

A LOOK BACK

These sidebars discuss a specific event or time period when the concept we're covering was particularly important. Taking lessons from this history is important to avoid repeating mistakes of the past.

CASE STUDY

If there's a specific current event or experiment that's especially relevant to the current topic, this is highlighted in this sidebar. Applying basic concepts to new examples is a great way to sink the ideas into your long-term memory.

Acknowledgments

To all my students, who continue to inspire me.

To my teachers, who set the standard I aspire to.

To my parents, who made me what I am.

To my wife, who gives me the support to keep working and learning.

To my son, who gives me hope for the future.

Special Thanks to the Technical Reviewer

The Idiot's Guides: Environmental Science was reviewed by an expert who double-checked the accuracy of what you'll learn here, to help us ensure this book gives you everything you need to know about environmental science. Special thanks are extended to Christopher Klinger.

Trademarks

The Basics of Environmental Science

Part 1 is designed to provide the most fundamental concepts you'll need to fully appreciate and understand the ideas presented throughout the rest of the book.

In the following chapters, I share a quick overview of the biggest environmental problems, along wit some of the different philosophies regarding how humans live on the planet. I give you a little historical context: how human society has changed since the time of the hunters and gatherers, and how our impact on the environment has grown. I also touch on some of the regulations that have bee passed to preserve our natural resources and the agencies in charge of enforcing these laws.

Finally, I provide general science background that's relevant to environmental science. Environment science is an interdisciplinary science and requires a basic understanding of a few concepts in chemistry, physics, and the nature of science itself.

The Big Picture

In This Chapter

- Issues stemming from interactions of humans with the Earth
- Differing views on environmental issues and human needs
- The inequality between developed and developing countries
- Sustainability, the goal of environmentalism

The Palm Islands are a chain of three artificial islands constructed in the Persian Gulf off the coast o Dubai. These islands, built in the shape of palm trees, extend the shoreline of Dubai by 320 miles. Th artificial beaches contain hundreds of homes, resorts, restaurants, and stores. How was this amount o manmade land constructed? What impact do these islands have on the natural environment of the shore? Where did the money come from to fund this massive project? While these seem like widely varied questions, they all can be answered within the scope of environmental science.

This chapter gives you a broad overview of the environmental science discipline, some of the central issues covered throughout this book, and the underlying goal of sustainability. Each of the ideas in th chapter serves as a foundation for everything that follows.

Very few of the issues and controversies environmental scientists face have clear-cut solutions. The consequences of action or inaction are often uncertain at the time decisions are made. When constructed, the Palm Islands prevented natural tidal movement, causing stagnant water inhospitable for life to form. This was addressed by cutting flow channels on either side of each island. Other problems remain, however. For example, the islands are believed to be sinking at a rate of about 5 millimeters per year.

The types of environmental problems humans face also vary from country to country. A poor nation will face water quality, sanitation, and disease issues due to lack of infrastructure and overpopulation Poverty leads to deforestation and poaching. A wealthier country is more likely to experience industrial pollutant contamination and resource overconsumption. Dubai, part of the United Arab Emirates, is a very wealthy country with a great deal of oil resources. These resources provide the means to build complex structures such as the Palm Islands.

Major Issues: The Big Three

The study of environmental science boils down to the interaction of humans with the environment. The environment itself refers to all the conditions that surround us—the climate, the air we breathe, the water we drink, and the presence of all the other living organisms around us. Each of the major environmental issues we face stems from these interactions.

The impacts we have on the environment are often much greater and longer lasting than they appear

first glance. This is one of the greatest challenges of studying environmental science.

Consider the use of coal to produce electricity. What impact does the use of this resource have? The coal must be mined, either on the surface or underground, exposing vast amounts of subsoil and placing miners in dangerous and unhealthy conditions. The coal is then transported by road or rail to power plant, where it is burned. The smoke produced by the power plant contributes to the formation of acid rain. As the acid rain falls, it stresses aquatic animals and plants, endangering their survival. Like a stone dropped into a pond, the ripples from using this resource continue far past the actual point of impact.

Natural Resource Depletion

Water, air, timber, coal, aluminum—these are resources used by the human population. While some these resources are *renewable* and are naturally recycled by the Earth's processes, others are *nonrenewable* and exist in limited amounts.

DEFINITION

A **renewable resource** is a substance that can be replenished within a human lifetime. A tree may take decades to regrow after it's harvested, but it's still renewable. A **nonrenewable resource** is a substance that, once consumed, will not be replenished within a human lifetime. An example is coal, which forms over millions of years.

Nonrenewable resources are the most likely to be exhausted. When metals are mined from the Earth' crust, they won't regenerate, at least not within the time frame of human reference. The amount of iron, lithium, or any other metal available within the Earth is *finite*.

Renewable resources are different, as they will replenish over time. A good example of a renewable resource is water. Human society consumes tremendous amounts of water for drinking, farming, and industrial use, but it eventually finds its way back into the environment and is reused.

Don't assume, however, that renewable resources can be used indiscriminately. Renewable resources are often depleted so quickly that they're unable to replenish at the same rate.

Air and Water Pollution

In addition to resources being consumed, they can also be degraded by human activities. This is *pollution.* This degradation can impact the most basic elements of living ecosystems: soil, air, and water. Pollution is considered a fundamental environmental issue because these resources are so basi and vital to all life forms on Earth.

Pollution is primarily released into air or water. This spreads the problem, as each of these substance moves through the Earth readily and quickly.

After it's released, air pollution tends to move in the direction of the prevailing wind currents. The New England states are sometimes referred to as "America's tailpipe" because much of the pollution produced within the Rust Belt states of the Midwest finds its way there. Industrial pollutants have been found in rural areas miles away from any power plants or factories.

Water pollution can also move, but not as freely as air. If pollutants are released into a lake or pond, they'll largely stay there. However, if they're released into a river, they can affect communities and

ecosystems downstream, eventually even finding their way into the ocean.

Loss of Biodiversity

Visit a public place and look around you. Consider the range of ages, ethnicities, and religious beliefs among the people you see there. These differences describe the diversity of the group. Now look at a natural ecosystem. Consider the different types of trees, shrubs, fungi, insects, mammals, birds, and other organisms you see or hear. This is the *biodiversity* of that ecosystem.

The number of species that exist on Earth is unknown, but it is estimated to be in the tens of millions. With so many species living in the same space, competing for the same resources, extinction of some species is inevitable.

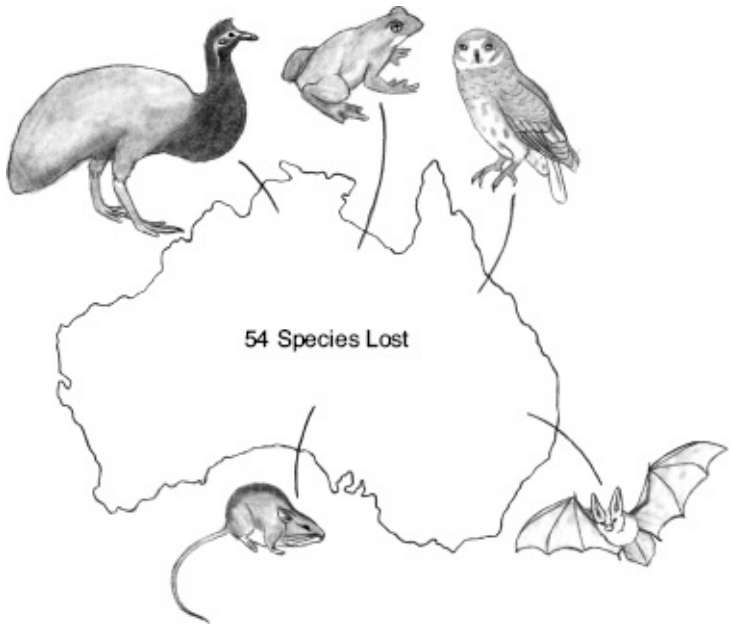
CASE STUDY

A famous paper published by Sepkoski and Raup in 1982 identified the “big five” major extinction events believed to have occurred during the history of life on Earth. The most recent is called the Cretaceous-Tertiary extinction event, as it separates those two geologic periods. Causes of this event are hypothesized to be huge amounts of dust entering the atmosphere from one or more asteroid impacts and increased volcanic eruptions. The dust blocked out enough sunlight to interfere with photosynthetic organisms. As much as 75 percent of all species may have gone extinct during this event.

Extinction occurs when a species completely dies out. This can happen naturally as other species evolve better ways to compete for the same resources or from a sudden catastrophic change, such as a volcanic eruption or meteor strike. Sudden, large extinction events are pretty rare, however. Assuming no great catastrophes, a typical ecosystem will experience an extinction rate of one mammal every 200 years.

How do humans influence this rate? Consider the example of Australia and the nearby smaller island of Tasmania.

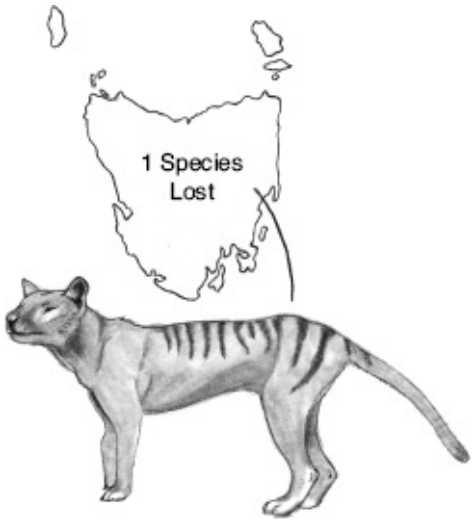
Australia has seen the extinction of 54 species, including mammals, birds, and amphibians, since the late eighteenth century. What catastrophic event underlies these extinctions? The first Europeans settled Australia in 1788, opening the way to increasing human population, consumption of natural resources, and the introduction of non-native species into the continent.



Fifty-four species have gone extinct in Australia since 1788, including mammals, birds, and amphibians. This is primarily due to the influence of European settlers.

One of the single most damaging decisions made by the first European settlers of Australia was the introduction of the European rabbit. The ecosystem was so ideal for the rabbits that their population exploded, stripping the land of vegetation the native species needed. The native animals, unable to compete with the rabbits, gradually disappeared. Suddenly, extinction rates normally associated with extremely rare catastrophic events occurred due to seemingly innocent human decisions.

The island of Tasmania, on the other hand, has not seen this level of destruction. The island was largely spared the huge infestations of invasive species, and it has a much lower extinction rate as a result.



Tasmania has seen only one extinction, the Tasmanian tiger, in the last two centuries. This matches the background extinction rate of mammals that would be expected outside of human influence.

The other important aspect about extinction is its permanence: once a species goes extinct, it will never return. Other species may take its place within an ecosystem. Species such as the Desert bandicoot in Australia will never return, although other closely related mammals may remain.

Ethics and Decision Making

Debates have sprung from the number of pressing environmental issues that have resulted from huma population growth. With any decision that uses a natural resource, releases a pollutant, or endangers an ecosystem, the human needs are weighed against the effects on nature.

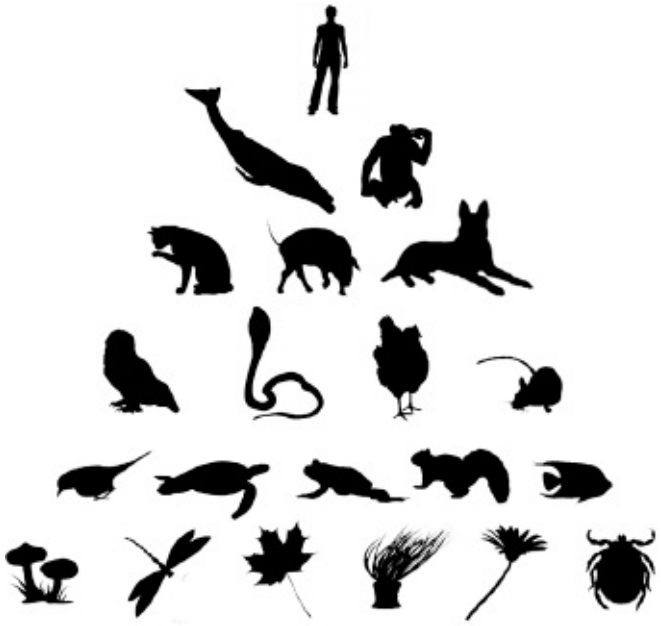
Given the complex nature of the environment and the long list of human needs, there will be multiple sides in any environmental debate or controversy. The position you take in regards to one of these issues is a reflection of your environmental ethics.

One of the earliest and most well-known environmental conflicts was the proposed construction of a dam in the Hetch Hetchy Valley in Yosemite National Park. The city of San Francisco was seeking a more reliable source of water to support a burgeoning population in the early 1900s, and the topography of Hetch Hetchy was ideal for creating a reservoir. Should the dam be constructed, despit

the seeming violation of the intended purpose of the national park?

Anthropocentrism

The word *anthropocentrism* literally means “human-centered.” Individuals with this philosophy believe the Earth and its resources exist primarily for human needs. According to this line of thinking humans dominate the Earth and should develop to benefit the population as much as possible.



The anthropocentrism environmental worldview places human needs above those of all other organisms and the environment as a whole.

For most of human history, this has been the most prevalent philosophy. This isn’t necessarily a bad or wrong viewpoint to take, because the human population does have a set of basic needs that must be met. Is it possible to be an anthropocentrist and still environmentally responsible?

A good example of this is Gifford Pinchot, the first chief of the U.S. Forest Service. He famously wrote, “Where conflicting interests must be reconciled, the question shall always be answered from the standpoint of the greatest good of the greatest number in the long run.” In other words, human needs are still a priority, but the needs of future generations are to be considered as well as the immediate ones.

Presented with the Hetch Hetchy debate, what would anthropocentrists do? Certainly, they would vote to construct the dam. The benefits to human society are numerous, from the improved water supply to San Francisco and surrounding areas to the tourist-friendly artificial lake that would fill in behind the dam.

Biocentrism and Ecocentrism

The center of the *biocentrism* philosophy is all life, rather than just humans. We are seen as but one species among millions. Essentially, every organism is believed to have its own value or purpose to the greater ecosystem or to Earth itself.

The ecocentrism philosophy is centered on nature as a whole. Value is not placed simply on living species, but on all aspects of the environment. This would include nonliving characteristics such as

climate, air quality, and water quality.

DEFINITION

Anthropocentrists make decisions strictly based on human needs, both short-term and long-term. **Biocentrists** look at the needs of other species besides humans, while **ecocentrists** consider the importance of maintaining entire ecosystems in the most pristine condition possible.

The ecocentrism environmental worldview considers humans as part of the environment. The well-being of humans as well as other species enters into any decision.

Making a distinction between biocentrism and ecocentrism is difficult, as individuals from each philosophy often come to similar conclusions. John Muir, founder of the Sierra Club, argued that the purpose of the national park was to preserve the ecosystems in their natural form. To change or alter this ecosystem, in his view, was sacrilegious.

The differences among anthropocentrists, biocentrists, and ecocentrists came into full focus during th Hetch Hetchy debate. Gifford Pinchot argued for the water needs of San Francisco's citizens. John Muir pled with Congress to leave Yosemite in its untouched, natural state.

As for the Hetch Hetchy decision, human needs won out. In 1913, the dam was approved for construction. The reservoir remains in use today and accounts for about a quarter of San Francisco's municipal water supply.

Same Planet, Different Worlds

To further complicate the list of environmental issues, debates, and philosophies, the types of issues faced by countries around the world are not all the same. Each country has a different level of wealth politics, and available resources.

One of the biggest factors influencing the environmental problems faced by any given country is its economic status. Wealthy countries and poor countries have huge differences in the sizes and composition of their respective populations.

Developing Countries

Developing countries are those with lower gross national products, lower literacy rates, shorter average life spans, and more rapid population growth. About 80 percent of the world's population fal within this definition, although they consume resources at a much lower rate. Examples include muc of Central and South America and Africa south of the Sahara Desert.

Environmental policy in developing countries is very much anthropogenic and short-term. This is often out of necessity, as the population may be on the brink of not surviving. The most common causes of death in these countries are disease and malnutrition.

Resource depletion is very common in developing countries. As an example, both forests and native animal species are considered renewable resources. Each will regrow and repopulate over time. However, forests are often cut down at such staggering rates that regrowth cannot keep up with this destruction. Overhunting is also a common problem, especially if specific parts of the animal are highly valued. Rhinoceros horns, for example, are ground and used as herbal remedies in many Asian countries.

CASE STUDY

A revolt following European colonization of Haiti led to the island being primarily populated by former African slaves. In the nineteenth century, any land that was fertile was allocated to the former slaves, who are now farmers. As the farmers passed their land to their children, it was divided into smaller and smaller parcels. The subsequent generations began to farm much more intensively and overused the land. Over time, the soil could no longer support crops. The farmers then moved to surrounding hillsides. Trees were cut down and sold, and the soil was used until it again became infertile. Now, much of the country cannot support crops, deforestation is prevalent, and famine is commonplace.

Developed Countries

In most ways developed countries are mirror opposites of developing countries. They have higher gross national products, higher literacy rates, longer average life spans, and much slower population growth. Only about 20 percent of the world's population lives in these countries, but they consume resources at a much greater rate.

Developed countries—those with the highest gross domestic products per capita in the entire world—include Singapore, Norway, the United States, and the United Arab Emirates.

To get a glimpse into some of the demographic differences between the developed and developed world, consider this comparison table of statistics taken as of 2011. The two countries chosen, the United States and Bangladesh, are very much at opposite ends of the economic spectrum.

Comparison of Developed and Developing Countries

Measurement	United States	Bangladesh
Life expectancy in years	78.2	48.3
Population growth rate	1.0%	2.7%
Gross national product per capita	$48,890	$910
Energy use per year per capita	10,381kWh	35kWh
Literacy rate	99%	38%

The Struggle for Sustainability

The ultimate goal of environmentalism is an idea called sustainability. This isn't a new idea. In fact, in 1972, the United Nations itself created an organization whose purpose was to promote sustainable living practices. Deterioration of the environment was a problem in countries all over the world. A study group established from this effort, called the Brundtland Commission, wrote a report that contains the best and most-cited definition of sustainability.

From that paper, "Our Common Future":

> Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

Simply put, the idea of sustainability is for the human population to live in such a way that its own needs can be met *indefinitely*. This often is not the case, however, both in developed and developing countries.

The "Tragedy of the Commons"

In 1968, ecologist Garrett Hardin wrote an essay titled "The Tragedy of the Commons," suggesting that the root of environmental problems was a conflict between the short-term interests of individual and the long-term interests of the society as a whole.

A *commons* is an area that isn't privately owned; rather, it's shared by the surrounding people. A modern example of this is international waters in the oceans. These areas of the oceans do not fall within the control of any one country, and thus no laws or regulations protect them. In theory, any individual could utilize these waters.

When it comes to the treatment of a commons, individuals will often deplete or overuse it as they see the most short-term benefit possible. Do renters behave differently from homeowners? Do public bathrooms look different from ones in private homes? Would you drive a rental car more carefully than your own car?

In the case of the world's oceans, much of the oceans suffers from pollution and overharvesting of stocks of fish. Ocean waters that fall within an individual country's control are less likely to suffer this problem, as the country is more apt to regulate fish harvests to preserve the industry in the long term.

Ecological Footprint

Both developed and developing countries struggle to meet the definition of sustainability, but it's the wealthier countries that consume far more, potentially depriving future generations of resources. One way to measure this difference is with an ecological footprint, a measurement of the total amount of land needed to support a given lifestyle. This includes farmland for food, forests for timber, mines fo minerals and fossil fuels, and so on.

The ecological footprint in a developing country is relatively small. A greater reliance on manual or animal labor, in addition to a lack of electricity, contributes to this size.

The ecological footprint for an average person in the United States is about 30 acres, while for an average person in India, it's closer to 3 acres.

What lifestyle differences account for this tremendous disparity? How much electricity does an average individual in each country consume? Does an average person in India have access to the sam array of personal electronics—laptops, cell phones, and video game systems? What are the differenc in diet? Many in India have a primarily vegetarian diet, which has much lower resource costs to produce. What percentage of India's population owns a car and drives frequently? Each of these adds up to a huge discrepancy in resource consumption.

This contrast in lifestyles clearly illustrates the differences in consumption between the two types of countries and the tremendous number of changes needed to create a more sustainable society.

The number of environmental problems facing us is vast, but not impossible to solve. Many of them stem from the same issue—that is, a tendency we as humans have to think only in the short term. If w could begin to consider the well-being of other species and societies, and shape our lifestyle accordingly, our species would be living much more sustainably.