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INTRODUCTION

Over an increasingly large area of the United States, spring now comes unheralded by the return of birds, and the early mornings are strangely silent where once they were filled with the beauty of bird song.

Rachel Carson (1962: 97)

Rachel Carson launched the modern environmental movement in 1962 when she published *Silent Spring*, a book that documented the harmful effects of pesticides on birds and other nonhuman species. The book was serialized in the *New Yorker* prior to its full publication and was widely read after it was placed in the Book of the Month Club and became a best seller on the *New York Times* list. Carson had been aware of the potential hazards of pesticide use since the 1940s, but she became especially concerned when one of her friends had published a letter reporting the deaths of numerous birds on her property after aerial dichlorodiphenyltrichloroethane (DDT) spraying. In *Silent Spring*, Carson argued that DDT can cause reproductive problems, such as sterility, weak eggs shells, and embryo death in a variety of bird species, which leads to population decline (Carson 1962). She warned that, one day, the world would have a silent spring (i.e., no birdsongs) if steps were not taken to restrict the use of DDT and other pesticides. Carson discussed several examples of how pesticides can harm human beings, including a case in which farm workers had suffered toxic reactions from pesticide exposures. She also claimed that the chemical industry had spread false or misleading information about pesticide safety and that government agencies had not carefully examined industry claims.

Carson was a scientist, writer, and devoted lover of nature. She was born on May 27, 1907 in Springdale, Pennsylvania. In 1929, she graduated from Pennsylvania College for Women (now known as Chatham College), majoring in science. She then studied at the Woods Hole Marine Biological Laboratory in Massachusetts. In 1932, Carson received a master's degree in zoology from Johns Hopkins University. She worked for the U.S. Bureau of Fisheries in the 1930s and became editor-in-chief of U.S. Fish and Wildlife Service publications. While working for the federal government, Carson wrote pamphlets on conservation of natural resources and edited scientific articles. She also wrote articles on nature for newspapers and magazines. In 1952, she quit her government position to devote more time to writing. She

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published a highly acclaimed book, *The Sea Around Us* in 1952, followed by *The Edge of the Sea* in 1955. As a result of these books and other publications, Carson became a well-known popular science writer. She was inducted into the American Academy of Arts and Letters and won a National Audubon Society Medal. In 1964, Carson published an essay, "The Sense of Wonder," about the importance of nurturing a child's sense of wonder about the natural world. Carson had a radical mastectomy in 1960, and died of breast cancer four years later on April 14, 1964 at age 56 (Lear 2009).

Silent Spring generated tremendous controversy as soon as it was published. Industry representatives and some scientists branded Carson as a subversive, hysterical woman, who lacked the qualifications to investigate the complex issues related to pesticide use. She received personal attacks and threats of legal action. Other scientists and members of the public shared her concerns and called for new efforts to protect the environment from hazardous chemicals and pollution (Lytle 2007). In June 1963, Carson gave testimony about the dangers of pesticides to the U.S. Senate Subcommittee on Government Operations. President John F. Kennedy also ordered the Science Advisory Committee to conduct an independent review of Carson's research. The Science Advisory Committee concluded that Carson's assertions about the potential dangers of pesticides were well-founded, a finding that promoted a strengthening of U.S. pesticide regulations (Lytle 2007). As a result of growing concerns about DDT's potential effects on human beings and the environment, Sweden banned DDT in 1970, and the U.S. Environmental Protection Agency (EPA) banned the use of DDT except for specific public health purposes in 1972 (Robson et al. 2010). In the United States, the EPA regulates the sale, distribution, and use of pesticides and other chemicals.

DDT was first synthesized by Austrian chemists in 1873, but the compound did not generate much interest until Swiss chemist Paul Müller patented it in 1940 and explored its uses as a pesticide. Müller won the Nobel Prize in Physiology and Medicine in 1948 for his work demonstrating that DDT can kill a variety of insect pests, including mosquitoes, lice, and houseflies (Nobelprize.org 2010). Research conducted since the 1960s has yielded vital information about how DDT can cause harm to wildlife and humans. DDT is a persistent organic pollutant (POP), which can accumulate in organisms higher up the food chain and slowly degrades in the environment (Longnecker et al. 1997). Inside an organism, DDT may break down into DDE or DDD, which may be metabolized into other forms. DDT is stored in fatty tissues. Predatory birds, such as eagles, falcons, and pelicans, are particularly susceptible to the effects of DDT. It is also highly toxic to cats, crayfish, shrimp, and some species of fish (Agency for Toxic Substances and Diseases Registry 2002), and has been classified by the National Toxicology Program (NTP) as moderately toxic to humans. DDT exposure has been linked to premature birth, low birth weight, and developmental problems, and is associated with an increased risk of some types of cancer. DDT has been classified by the NTP as reasonably anticipated to be a human carcinogen (Agency for Toxic Substances and Diseases Registry 2002; National Toxicology Program 2009). There is some evidence that DDT causes genetic damage and disrupts human reproductive and endocrine functions even

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Figure 1.1. Rachel Carson (courtesy of the U.S. Fish and Wildlife Service).

in low doses (Longnecker et al. 1997). In 2001, more than 150 countries signed the Stockholm Convention on Persistent Organic Pollutants, which calls for the elimination of DDT and ten other POPs (Robson et al. 2010). See Figure 1.1 for photo of Rachel Carson.

Silent Spring initiated an ethical and political debate concerning the proper use of pesticides that continues today. A pesticide is a substance used to destroy, control, repel, or mitigate a species considered to be a pest, such as some types of insects, ticks, rodents, fungi, plants, microbes, worms, and even fish and birds (Environmental Protection Agency 2010a). People have been using chemicals to control pests since the nineteenth century.

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Over 5 billion pounds of pesticides are used worldwide each year. Although pesticides can have harmful effects on people, nonhuman species, and the environment, they can also promote human health and well-being by preventing the spread of disease and improving crop yields (Robson et al. 2010). Though many environmental groups oppose the use of pesticides (Beyond Pesticides 2010), industry groups and many scientists endorse the safe and appropriate use of pesticides (Environmental Protection Agency 2009a; Croplife America 2010).

One of the chief criticisms of Carson's book is that it did not pay sufficient attention to the vital role that pesticides play in promoting human health. DDT had been widely used in the 1940s and 1950s to control disease-carrying mosquito populations in the United States, Europe, and the South Pacific. As a result, malaria and typhoid fever have been virtually eliminated as public health threats in many parts of the world (Robson et al. 2010). Critics argued then – and continue to claim now – that Carson's book is an antipesticide manifesto that undermines human health (Lytle 2007; Murray 2007). But this criticism misrepresents Carson's views about pesticides. Carson recognized the importance of using effective measures, including pesticides, to prevent insect-borne diseases:

> All this is not to say there is no insect problem and no need of control. I am saying, rather, that control must be geared to realities, not to mythical situations, and that the methods employed must be such that they do not destroy us along with the insects. . . . It is not my contention that chemical insecticides must never be used. I do contend that we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely or wholly ignorant of their potentials for harm. (Carson 1962: 20, 22)

Carson argued that the indiscriminate use of pesticides should be eliminated in favor of responsible use. She advocated alternatives to pesticides, such as the use of natural predators and sterilization, to control insect populations. Carson also warned that overuse of pesticides could be counterproductive because it could lead to pesticide resistance (Carson 1962).

The use of DDT to prevent the spread of malaria illustrates vividly some of the ethical dilemmas concerning pesticide use (Resnik 2009). Although malaria is no longer a significant problem in most of the world's developed nations, many developing nations still suffer under the burdens of this disease. Malaria is a parasite carried by females of the genus *Anopheles*. It produces fever, chills, headaches, and muscle pains, and can cause anemia, impaired consciousness, convulsions, kidney failure, and death. Approximately 350 million–500 million people contract malaria each year, mostly in nations in sub-Saharan Africa and the tropics (Centers for Disease Control and Prevention 2007). More than three million people die each year from malaria, most of them young children. Every thirty seconds a child dies from malaria (Kapp 2004). While there are medications that can treat malaria, prevention is the preferred method for reducing the impact of the disease on the human population, especially in countries that lack adequate health care resources. Methods of preventing infection include wearing protective clothing, using mosquito nets and repellants,

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as well as controlling the malaria vector (World Health Organization 2010). Vector control includes methods that disrupt the life cycle of mosquitoes, such as eliminating sources of stagnant water that serve as breeding grounds for mosquitoes, and the application of pesticides to kill mosquitoes in their adult or larval forms. In 2006, the World Health Organization (WHO) announced it would support limited use of DDT, such as spraying the chemical on interior walls or mosquito netting, to control malaria (World Health Organization 2006). Infectious disease specialists, public health advocates, and others have also supported limited use of DDT to control malaria (Roberts et al. 2000; Kapp 2004). Many sub-Saharan countries, including South Africa, Uganda, Zambia, Zimbabwe, and Kenya currently use DDT to fight malaria (Hecht 2004).

The WHO's endorsement of the limited use of DDT for malaria control has generated considerable controversy. Opponents of DDT use argue that because the chemical persists in ecosystems for many years and accumulates in species higher up in the food chain, it poses a risk to nonhuman species, including some species of birds and fish. DDT also poses risks to human health, which are not well understood at present, such as interference with reproductive and endocrine functions and neurological development. Moreover, some mosquito populations have become resistant to DDT as a result of overuse, and continued use may increase resistance. DDT may also disrupt ecosystems by altering the balance of different species in the food web, such as predatory birds. Disruption of ecosystems can have broad-ranging effects on human and nonhuman populations (Wilcox and Jessop 2010). Other strategies for controlling the spread of malaria, including medication, protective clothing and nets, and even the limited use of pesticides other than DDT, are preferable to limited DDT spraying, according to many (Berenbaum 2005; Pesticide Action Network of North America 2007).

The question of whether to use DDT to control malaria raises complex scientific and ethical issues:

- What are the hazards to human health and the environment posed by the limited use of DDT? Can these hazards be mitigated or controlled?
- Will limited use of DDT increase DDT resistance? Can DDT resistance be prevented?
- What are the alternatives to DDT use? How safe and effective are these alternatives?
- How should we weigh the uncertain long-term risks to human health posed by DDT use, such as endocrine disruption or cancer, against the near certain short-term benefits, such as malaria prevention?
- How should we balance human health against risks to nonhuman species and the environment posed by DDT use?
- Because children are more likely to die from malaria than adults, should public health measures emphasize short-term benefits to children over possible long-term risks to adults?
- What is the extent of a government's moral authority to regulate chemicals, such as pesticides, that can save lives but may also cause harm?

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These and other issues related to DDT used to control malaria exemplify some of the themes that are the focus of this book. Dilemmas, problems, and questions concerning the relationship between human health and the environment have come to occupy center stage in a number of different areas of public concern, such as genetically modified (GM) crops, antibiotic resistance, air and water pollution, hazardous waste disposal, food safety and nutrition, meat eating, urban planning, housing, occupational safety, disaster preparedness, nanotechnology, climate change, and population control. Many authors have written about these topics from various disciplinary perspectives including ecology, public health, medicine, toxicology, economics, law, sociology, theology, philosophy, and political science. I have chosen to add my voice to this conversation in order to offer a unique viewpoint that incorporates insights from ethical theory, environmental science, and public health. The title of my book – *Environmental Health Ethics* – signifies this perspective.

Because many of the issues are complex, timely, and nuanced, this book should be regarded as a starting point that prompts further debate by scholars, scientists, students, and others, not as a definitive analysis of every topic under consideration. Indeed, because the latest scientific and legal developments have an important bearing on most of these issues, some of the conclusions drawn in this book may be out-of-date in a few years. That concern need not worry us here because my aims are to introduce specialists and lay readers to unfamiliar issues; explore relationships among ethics, the environment, and human health; and incorporate insights from diverse fields of study. The net result of this endeavor will, I hope, open up new areas of inquiry and offer fresh perspectives on old problems.

One of the central themes of the book is that most of the difficult environmental health questions we face involve conflicts among fundamental values, such as human rights, economic development, public health, justice, and environmental protection. To think clearly about resolving these conflicts it is important to develop a conceptual framework that distinguishes among these different values and includes a method for resolving conflicts

Traditional ethical theories lack the tools to deal with environmental health issues, because they tend to be human centered, focusing on human rights, duties, and values, with scant attention to other species or the environment. In the last two decades, philosophers and theologians have developed theories that extend the scope of ethical concern beyond the human realm to consider the value of other species and the environment. Most of these new theories, however, deal with human interests in general terms and do not distinguish between human health and other values, such as economic development and social justice. However, it is important to think about how all of these different values interact and potentially conflict to deal with environmental health issues (Resnik 2009).

For example, water pollution, which is often a by-product of economic development, can threaten nonhuman species and ecosystems. It is tempting to think of clean water policy debates as boiling down to economic development versus the environment. However, the issues are not that simple. Water pollution also negatively impacts human health and has implications for social justice because it may affect people differently, depending on where they live. However, economic development can have positive effects on human health and

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social justice by creating jobs, income, housing, and wealth. Poverty and unemployment contribute to poor health (Marmot and Wilkinson 2005). Government policies dealing with water pollution therefore need to take into account not only environmental protection but also economic development, human health, and social justice.

Many commentators and organizations tend to view promoting human health and protecting the environment as complementary objectives. For example, the mission of the Environmental Protection Agency (EPA) is to protect human health and the environment (Environmental Protection Agency 2011a). Though environmental protection and public health promotion often go hand-in-hand, they are still distinct values that may sometimes conflict, as illustrated by the dilemma mentioned earlier concerning the use of DDT to control malaria. Environmental protection may also conflict with public health when a community is deciding whether to build a dam on a river to provide enough water for its population. Having an ample supply of clean water is essential for public health, but damming the river could have adverse impacts on species and the ecosystem (Ford 2010).

A key question explored in this book, therefore, is how best to balance competing values in environmental health decision making. In Chapter 4, I will describe a method for ethical decision making that aims to achieve a fair and reasonable balance between competing values and moral principles. It is important to consider environmental and public health concerns, as well as economic and social ones. My balancing approach stems from recognition that ethical and policy decisions often involve difficult choices between competing interests and values, and that practical answers usually reflect compromises among opposing viewpoints (Rawls 2005). Decision-making methods with a particular ideological, economic, or religious slant are likely to alienate opponents, instead of inviting them to engage in a serious discussion about what to do. Compromises may not be palatable to those who maintain unwavering allegiance to particular principles or ideals, but they are often the best way to involve different stakeholders, such as environmentalists, public health advocates, and leaders from business, industry, and government in working toward effective solutions to difficult problems (Brand 2009; Master and Crozier 2011).

Another theme of the book is that interactions between human health and the environment put a new twist on some of the traditional questions of ethics. For example, the conflict between individual rights and the common good is a perennial issue for ethics, political philosophy, and legal theory. In the environmental health arena, questions about the moral basis for government restrictions on property rights play a critical role in policy debates about urban sprawl, a pattern of uncontrolled development around the edge of a city. In the United States, communities have taken various measures, such as prohibitions on new housing construction on rural land and zoning laws that mandate high-density, mixed-use development, which are intended to counteract urban sprawl. Public health advocates and environmentalists have championed these measures as a way to reduce the impact of diseases associated with urban sprawl, such as obesity, diabetes, heart disease, and asthma, and to protect the environment from further damage (Heaton et al. 2010). Property owners and developers have argued, however, that these policies are an unjustified restriction on

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their rights, and they have succeeded in forestalling antisprawl policies in many locations (Resnik 2010).

Justice is another traditional ethical concern that appears in a different light when considered in the context of human health and the environment. For many years, debates about justice have focused on social institutions and relationships among human beings. For example, questions about the distribution of income and wealth in society have to do with the structure of social institutions (Rawls 1971). As we shall see in this book, however, questions about justice also arise when one considers the health impacts of pollution, urban development, waste disposal, climate change, energy production, and other environmental issues. It is important to address questions concerning the distribution of health in the environment, and processes for making decisions related to environmental policies (Shrader-Frechette 2002, 2007a). Various chapters in this book will highlight these issues, and an entire chapter will be dedicated to environmental justice.

The plan for the book is as follows. Chapters 2 to 4 will examine the fundamental issues related to environmental health ethics, including an overview of environmental health (Chapter 2) and ethics (Chapter 3); and development of a principle-based approach to ethical decision making related to environmental health (Chapter 4). Chapter 4 will articulate principles for decision making, including respect for human rights, promotion of social utility, justice, protection of animal welfare, stewardship of natural resources, sustainability, and precaution. Ethical decision making concerning environmental health issues should strive to achieve a fair and reasonable balance among these different principles. Decisions and policies should also be consistent and based on evidence and arguments open to public criticism. Chapters 5 to 11 will apply the conceptual framework developed in the first part of the book to practical problems related to environmental health, such as GM crops, pesticide use, pollution, food safety and nutrition, nanotechnology, housing, urban planning, occupational health, population control, climate change, and research with human subjects. Chapter 12 will summarize the major findings and conclusions of the book.

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2

AN OVERVIEW OF ENVIRONMENTAL HEALTH

WHAT IS ENVIRONMENTAL HEALTH?

There are a number of different ways of defining environmental health. Some describe it as a scientific field of study similar to biology or chemistry, while others refer to it as an applied discipline similar to medicine or public health, and still others include both characterizations (Fromkin 2010; World Health Organization 2010b). The National Institute of Environmental Health Sciences (NIEHS), a branch of the National Institutes of Health (NIH), describes environmental health as both a scientific field of study that attempts to understand "the complex relationship between environmental risk factors and human biology within affected individuals and populations" and as an applied discipline that "uses this knowledge to prevent illness, reduce disease, and promote health" (National Institute of Environmental Health Sciences 2006: 5).

Many different scientific disciplines develop knowledge related to environmental health, including: ecology, toxicology, epidemiology, exposure biology, environmental medicine, genetics and genomics, cell and reproductive biology, endocrinology, neurology, microbiology, environmental economics, climatology, and meteorology (Frumkin 2010a). Applied environmental health disciplines implement practices and policies that promote environmental health. These include: occupational health, industrial hygiene, solid and hazardous waste management, water management, public health, forestry management, urban planning, agriculture, environmental engineering, ergonomics, and environmental law and ethics (Frumkin 2010a). (See Table 2.1.)

To clarify the definition of environmental health, it is important to distinguish between different environmental risk factors. Biological factors include the various organisms and species in our environment, such as bacteria, fungi, food crops, trees, birds, insects, cattle, rodents, as well as larger units of biological organization, such as ecological communities, ecosystems, and the biosphere (Frumkin 2010). Chemical factors include water, oxygen, carbon dioxide, nitrogen, phosphates, pesticides, food preservatives, industrial waste, heavy metals, and other substances that have an impact on health (Frumkin 2010). Physical factors include the physical aspects of our environment, such as geology, weather, gravity, heat, and electromagnetic radiation (Frumkin 2010). Social factors include characteristics

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Table 2.1. *Environmental Health Disciplines*

Scientific Disciplines	**Applied Disciplines**
Ecology	Solid and hazardous waste management
Toxicology	Hydrology and water management
Exposure biology	Occupational health and industrial hygiene
Epidemiology	Public health
Environmental medicine	Urban planning
Genetics/genomics	Civil engineering
Cellular and reproductive biology	Environmental engineering
Endocrinology	Environmental consulting
Neurology	Agriculture
Microbiology	Pest management
Meteorology and climatology	Forestry management
Environmental economics	Environmental law and ethics

of human societies that can affect health, such as warfare, racism, poverty, religion, buildings, infrastructure, social institutions, and occupations (Marmot and Wilkinson 2005; Barr 2008). Additionally, many human diseases result from gene-environment interactions (Olden 2006). For example, Type II (insulin-resistant) diabetes results from genetic predispositions in combination with excessive caloric intake and insufficient exercise (American Diabetes Association 2010).

Although the definition of environmental health should be broad, it is prudent to focus research on environmental factors that we are able to control or mitigate. For example, we have no control of the amount or type of solar radiation that reaches the Earth from the Sun. We do, however, have an ability to affect the protective ozone (O_3) layer in the atmosphere, which blocks harmful ultraviolet radiation. In the 1970s, scientists discovered that a variety of compounds, such as chlorofluorocarbons (CFCs), cause ozone depletion when released into the atmosphere. Recognizing the dangers of ozone depletion, countries around the world have reached international agreements and adopted domestic laws that regulate CFSs and other ozone depleting substances (Environmental Protection Agency 2010b). While the study of the Sun's energy production should be left to astrophysicists, environmental scientists can study the formation of the ozone layer, how different compounds affect it, and how ozone depletion can cause diseases, such as skin cancer.

Focusing on aspects of the environment that we can control or mitigate does not mean we should take a stoic attitude toward the environment, accepting whatever fate may befall us, because our ability to affect or respond to the environment changes with advances in science and technology. For example, at one time it was not possible to accurately predict natural disasters such as hurricanes, tornadoes, tsunamis, floods, and volcanoes. Advances in meteorology, geology, and oceanography have made it possible to forecast, prepare for, and respond to natural disasters. Advances in engineering, architecture, building construction, and other sciences have allowed us to create structures that are able to withstand

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