CHAPTER 17

Rachel Carson & *Silent Spring*

DOUGLAS ALLCHIN

☐ INTRODUCTION

In the late 1950s, the United States enjoyed an economic prosperity that it had not experienced for three decades. Industry boomed after World War II. Comfortable middle-class neighborhoods—each house with its own lawn—began to expand into the suburbs of metropolitan areas. Scientific research, too, expanded. "Better living through chemistry" was the watchword of one company. Many chemical pesticides, such as DDT and aldrin, were used to control insect populations and thereby reduce disease. Farm production, too, boomed. New fertilizers and pesticides were widely available and allowed better crop yields. Farming was one of many activities indebted to the chemicals industry. The pesticides DDT and aldrin were emblems of the triumph of technology.

But amid the welcome prosperity, there were signs that all was not ideal. In residential communities, some people noticed that songbirds were declining. Birds seemed to be afflicted after heavy pesticide sprayings. One birdwatcher in Massachusetts, Olga Huckins, expressed her concerns to the editor of the Boston *Herald* in 1958:

> The mosquito control plane flew over our small town last summer. Since we live close to the marshes, we were treated to several lethal doses as the pilot criss-crossed our place.... The "harmless" shower bath killed seven of our lovely songbirds outright. We picked up three dead bodies the next morning right by our door.... All these birds died horribly, and in the same way. Their bills were gaping open, and their splayed claws were drawn up to their breasts in agony.

Her experience contradicted state officials, who had advised her that the spraying mixture—fuel oil with DDT—was "entirely harmless." She noted with irony that the grasshoppers and bees were gone, but not the mosquitoes themselves.

Mrs. Huckins was no idle birdwatcher, however. She asked an acquaintance, Rachel Carson (Figure 17.1), whom she might consult in the government. Carson had earned wide acclaim with two best-selling books popularizing marine biology. In these books, Carson evoked a fascination and respect for the ocean and its many crea-

FIGURE 17.1 Rachel Carson near her home in Maine while she was writing *Silent Spring*. *Source:* ©1962 Erich Hartmann/Magnum Photos Inc.

tures. She conveyed a sense of the delicate balance of nature. After a few inquiries, Carson realized that scientific experts knew much about the effects of pesticides, though the knowledge was not guiding policy decisions. A crisis seemed imminent. In part, Carson saw pesticides as a threat to the living things that she cherished and wrote about. She decided that she must write and inform the public about pesticides.

The challenge facing Carson was similar to that faced by many biologists: to marshall available evidence and convince others (see Chapters 2 and 3). It was not just a matter of *what* was known, but also *who* knew it. Knowledge is valueless if it remains isolated among a few experts, buried in journal articles, or fails to affect public affairs. The case raises an important question in doing biology: Who is responsible for ensuring that biological knowledge reaches the relevant audience? Also, if the information is technical, how do you make it understandable while also meaningful? Ultimately, for the vast majority of people who are not biologists, what *counts* as biological knowledge?

Carson's solution on this occasion was to write a full-length book for a public audience. Its title, *Silent Spring*, drew on an image from Mrs. Huckins: a community suddenly made silent from loss of life due to pesticides. *Silent Spring* was enormously influential. It not only raised public concerns about pesticides but also helped launch an environmental movement that still continues decades later. How did Carson solve the problem of communicating biological knowledge?

WHO NEEDED TO KNOW WHAT ABOUT DDT?

The history of one pesticide, **DDT** (dichloro-diphenyl-trichloro-ethane), illustrates how knowledge can change—and with it, social values and practices. DDT was first

synthesized in 1874 and for the next several decades was just another complex molecule, of limited interest to a handful of specialists. In 1939, however, Paul Müller of Switzerland discovered that DDT could kill insects. With this new knowledge, DDT became relevant to many people in agriculture and public health.

Insects can destroy crops. They can also spread disease organisms. Mosquitoes, for instance, can carry malaria from one human or animal to another. The problem in both cases is similar, as Carson noted in her opening chapter: managing a dense population composed entirely of individuals of one species—a **monoculture**. When insect pests enter a monoculture, they can travel easily from plant to plant. As they reproduce, the rate of spreading is compounded. The pattern is similar to a disease epidemic in a human population. When a disease agent infects one human, the close proximity of humans allows it to infect many others. In both cases, halting the spread of organisms is difficult. Another problem is weeds—"pests" of another sort. The problems of weeds and pests are also familiar to homeowners trying to tend a grass lawn—another monoculture. For humans to manage crops, lawns, and the spread of disease, they must minimize the numbers of pests as much as possible; hence, pesticides.

The knowledge that DDT could kill insects changed its social value and use. During World War II, the Allied forces started using DDT to control the spread of diseases. Their success dramatically demonstrated DDT's future potential. Carson observed that "almost immediately DDT was hailed as a means of stamping out insect-borne disease and winning the farmers' war against crop destroyers overnight." The discoverer of DDT, she noted, won a Nobel Prize in 1948. Farmers, officials at the U.S. Department of Agriculture, and public health officials all saw DDT as a valuable solution to their problems.

DDT, biochemists later learned, interferes with the cell's energy-processing system. (It enters the mitochondrial membrane and destroys the energized gradient that fuels the making of ATP—see Chapter 8.) DDT and many other pesticides are thus poisons. Carson portrayed them in emotional language as "elixirs of death." Pesticides are not always lethal specifically to insects, however. The birds outside Mrs. Huckins's door had suffocated internally from DDT (at the cellular level). Such chemicals should be called "biocides," not "insecticides," Carson argued. Humans, too, could be affected in large enough doses. No wonder, Carson noted: many pesticides were derived from chemical weapons developed during World War II.

Because DDT is a complex synthetic compound, many organisms have no enzyme for breaking it down. Organisms can neither digest it as food, nor excrete it, nor destroy it—as they often do with other poisons. Rather, DDT collects in fat and liver tissues. If enough accumulates, the organism can die. If, instead, the organism is eaten, the DDT is transferred to the predator. Animals later in the food chain, such as carnivorous fish and birds of prey, tend to accumulate large amounts of DDT. The DDT concentrates in successive stages in a food chain: the effects of small amounts of DDT in the environment become amplified.

As World War II ended, Carson and others became aware of the previously unknown aspects of DDT. For them, the potential benefits of DDT were coupled with dangers to both wildlife and humans. In 1944, the American Association of Economic Entomologists thus issued a statement in an effort to amend "over-optimism and distorted impressions" about DDT. The following year, scientists wrote about the dangers of DDT in *Harper's* and *Atlantic Monthly*. In 1950, the Food and Drug

Administration announced further that it was "extremely likely the potential hazard of DDT has been underestimated." But the use of DDT and similar pesticides continued. The image of DDT as a triumph of science persisted and eclipsed other concerns.

DDT is, in some ways, unrepresentative as a pesticide, but it was central for Carson. The case of DDT also highlights the challenges facing someone who wants to inform the public about the biological implications of using any pesticide. How does this information get conveyed? Who funds publications or media presentations? Who needs to know what?

PROBLEM

Consider the task of communicating knowledge about DDT in the late 1950s to the public. Sketch the challenges involved. What information is important to convey? To whom? By what media? How might you deal with preexisting images of DDT?

A VOICE FOR SCIENCE?

Who communicates biological knowledge to the public? In this case, Rachel Carson was well positioned for the task. First, Carson had been trained in biology. She first became interested in nature during her youth, when she had wandered in the orchards and woods surrounding her home. Carson might not have become a biologist, though, had it not been for a required science course at college. Carson was inspired by her teacher, who encouraged her to pursue a career that she had not imagined (in 1926) as open to women. Carson changed majors. She went on to earn a masters degree in marine biology at Johns Hopkins University. In her thesis work, she demonstrated her meticulous skills by dissecting embryos, preparing slides, and describing in detail how a kidney first developed and then disappeared in a maturing catfish. Given her background, Carson was able to understand pesticides from a biological perspective.

Carson was also a talented writer. She could therefore interpret technical information for a general audience. Carson's writing skills were also rooted in her childhood. At age 11, she won her first writing prize—one of many over her lifetime. Rachel's mother and her teachers nurtured what they perceived as a special talent. After graduate school, Carson's opportunities took her into a career of writing about biology. At first she wrote documents for the public at the U.S. Fish and Wildlife Service (she was only the second woman hired there in a nonsecretarial position). Later, she wrote popular books about the sea, *The Sea Around Us* and *The Edge of the Sea*, which received many awards. Carson's fluid writing style earned her many readers.

Writing skills contributed to Carson's work in another significant, yet less obvious way. Carson needed to support herself while researching and writing about pesticides. Fortunately, due to the success of her books and her royalties from them, she had been able to retire from her government work. Her modest wealth allowed her to pursue and complete a project that, even with some secretarial assistance, eventually spanned four years. Later, Carson's relative financial independence would become even more important. Claims about biology can often be interpreted in the context of the organization that funds the research or publication. Because no one had sponsored Carson's work, others could not easily discount it as reflecting the bias of some specific interest group.

As reflected in her popular writing, Carson appreciated deeply the whole of nature. When she thought about pesticides, therefore, she did not view them exclusively from the perspective of agricultural yields or the eradication of disease, as farmers or public health officials did. The scope of her biological view was wider. She also considered animals in the habitat where pesticides were sprayed, the food chains of which the insects were a part, and the effect of pesticides seeping into the soil and groundwater. Carson's concerns allowed her to highlight aspects of DDT and similar pesticides that many other persons, with their own immediate concerns, did not.

Carson had not pursued a career as an ecologist or chemist. According to her credentials, then, she was something of an outsider to pesticides research. This might have affected her capacity to be an informed voice for science. Yet Carson's broader focus also allowed her to synthesize the work of many researchers. To convey her views about the causes of cancer in humans, for example, Carson drew on data from many different sources. She could thereby recognize recurring patterns that suggested a link between pesticides and cancer. While her conclusions relied on others'—some of which have since been challenged—today her broad conclusions about toxic chemicals in the environment remain confirmed. Carson was thus qualified, while differing from scientists who worked in the lab or field. Indeed, by the end of her work, Carson probably knew more about the ecological, physiological, and social aspects of pesticides than any single researcher.

Carson was guided by her expertise, but what motivates someone to distribute biological knowledge? Here, Carson's feelings about the importance of that knowledge were probably significant. In her letters discussing the proposed book, she commented how pesticides represented an "alarming threat to human welfare, and also the basic balance of nature on which human survival ultimately depends." She reported to a close friend several months later that "there would be no peace for me if I kept silent." Carson adopted the project with a sense of mission.

The effort to inform the public in this case also had political implications. Challenging the pristine cultural image of pesticides would mean taking on the entire chemicals industry. Carson would need a good dose of confidence, even if she had strong evidence to support her claims. Moreover, she was certainly not blind to assuming this role in an era when women were not yet widely respected as leaders. Carson had certainly distinguished herself during her tenure in the government, lastly as director of the Public Information Division at the U.S. Fish and Wildlife Service. Yet, as would become evident later, assuming the voice of scientific authority had significant consequences. Carson's courage and conviction were integral to her project.

THE CHALLENGE OF WRITING ABOUT PESTICIDES

The task of writing effectively about pesticides in 1958 involved many challenges. For Carson, the prospect was very different from writing about tide pools, sponges, or sea salts. Information about the dangers of pesticides would not lend itself easily to her award-winning lyrical and poetic style. In addition, the audience would be diverse, from the general public to farmers and government administrators. Finally, the topic was highly political. This would be no mere "popularization" like her earlier books.

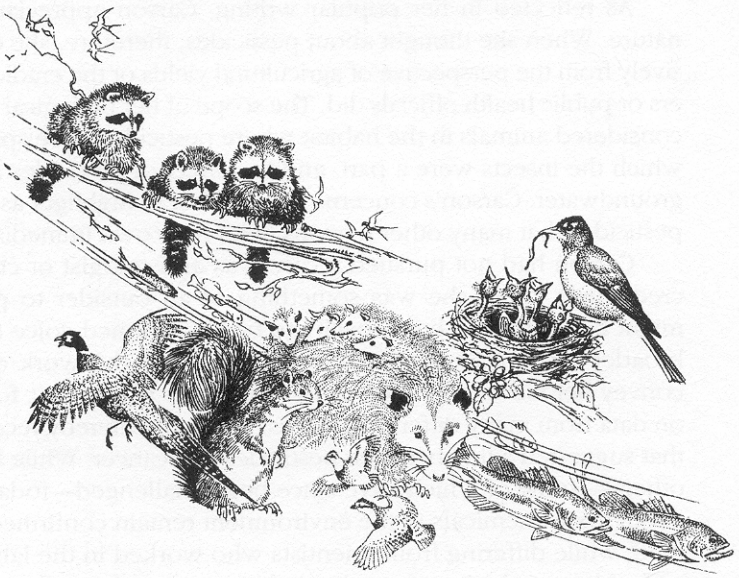

FIGURE 17.2 An illustration opening a chapter of *Silent Spring*. Was it appropriate to couple such images with the scientific information Carson presented to the public? *Source:* Illustration from *Silent Spring* by Rachel Carson.

Carson might easily have provoked public opinion by writing an inflammatory book criticizing pesticides without reference to scientific studies. Alternatively, she might have written dispassionately about the scientific details of pesticides. But Carson did neither. First, she wanted her readers to view pesticides as many biologists did. Given cultural prejudices, this would not be easy. It would not suffice merely to present information that was accurate and well documented. Carson would also have to *convince* others that the information was sound.

Carson was thus aware that her research had to be meticulous. In 1958, for example, she wrote to a former colleague asking about the decline of bird populations. But, she added, information would have to "hold up under fire." She used only claims supported by independent studies. Eventually, Carson devoted a full one-seventh of her book to documenting her sources.

At the same time, Carson chose not to write a strictly technical document. She interpreted the information in vivid images. She used such words and phrases as "sinister," "evil," "grim specter," and "ruthless power" alongside statistics or details about the ecological effects of pesticides. In addition, each chapter began with a hand-drawn and often romanticized illustration (see Figure 17.2). The technical information appeared in a primarily nontechnical context.

The sense of reverence for life, which permeated Carson's earlier writing, also guided her writing in *Silent Spring*. Rather than revel in the wonders of life, though, she portrayed the tragedy of loss of life. She cast human intervention in nature and threats to life as dangers to prevent. She selected information about the health effects of pesticide residues on food, for example, or the deaths of fish or small

mammals to illustrate how respect for life had been violated. "By acquiescing in an act that can cause...suffering to a living creature," she asked her readers, "who among us is not diminished as a human being?"

The project of writing about pesticides also had a personal dimension. Ironically, Carson was diagnosed with breast cancer in 1957, just before starting work on a book that argued that the uncontrolled release of chemicals in the environment caused cancer. Carson continued treatment for her cancer through 1958. At the end of the year, her mother died. While such a loss would be difficult for almost anyone, Carson, who had been extremely close to her mother all her life, was deeply affected. Around the same time, Carson's sister died, and she assumed the additional responsibility of raising her nephew. Carson's cancer did not abate, and in 1960 she had a radical mastectomy. Carson had settled into a small community on the coast of Maine, where she became very close friends with one neighbor. Given the several tragedies that Carson experienced, we can only imagine the importance of the personal support that Carson received while writing *Silent Spring*.

FUELING AN ENVIRONMENTAL ETHOS

Carson's argument about pesticides was both specific and general. In her specific argument, she focused on how individuals use or apply chemical pesticides. Carson did not argue against all pesticides. She suggested that selective use of chemicals might be appropriate, when and where the negative effects could be controlled. Only the indiscriminate use of especially powerful pesticides posed problems.

Carson did not make her specific criticism without offering an alternative. She was well aware, for example, that arsenic compounds and other poisons used earlier had been far worse than DDT. Carson advocated instead natural chemicals and **biological control**. She urged farmers to use an understanding of nature to control nature. They should find plants that already produced chemicals that deterred insects from eating them. They should introduce insect predators, diseases, or parasites, or promote the conditions under which they would thrive. In Carson's view, the pest problem was solvable. But farmers must first learn to respect the many interactions in nature. The solution for Carson was primarily biological, not chemical.

Carson's message about biological control was lost on many readers. They may well have been responding to her more general argument and the imagery associated with it. While talking ostensibly about pesticides, Carson drew on metaphors about the balance of nature, the integrity of its interactions, and control of nature. She highlighted very specific connections. She linked the dwindling number of songbirds, for example, to human decision making, not just to pesticides. Likewise, from the failures of pesticides to control Japanese beetles and fire ants, she drew an explicit moral about human attitudes towards controlling nature. Ultimately, *Silent Spring* was not just about pesticides.

For Carson, on a more general level, humans had not considered the complex interactions of living systems. Nature had a certain integrity or balance that was disrupted when humans introduced their synthetic chemicals. Carson viewed nature holistically, as a system. She saw that an influence in one part thus had the potential to upset

the system disproportionately throughout (even if at first the system could manage the slight perturbations). The fundamental problem with pesticides, Carson argued, was not simply their undesirable effects. Rather, it was human arrogance in striving to control nature. Here, Carson stepped well beyond the biology of pesticides. She critiqued public attitudes about the environment revealed by the social use of pesticides.

This larger theme formed a framework for the information about pesticides and dominated the structure, language, and examples in *Silent Spring*. The opening epigram (quoting another author) epitomized the message for many readers:

> I am pessimistic about the human race because it is too ingenious for its own good. Our approach to nature is to beat it into submission. We would stand a better chance of survival if we accommodated ourselves to this planet and viewed it appreciatively instead of skeptically and dictatorially.

Carson's book was a plea for recognizing the complexity of nature and its apparent fragility—vividly illustrated in the history of (mis)using chemical pesticides. She wanted humans to reassess their technologies and their relationship with nature.

Given the recurrent images about the control of nature, it may be somewhat ironic that Carson's alternative to chemical pesticides was itself another form of control: biological control. Yet readers perceived the book as expressing an emerging environmental way of thinking. One book reviewer may have captured the view of many readers when he wrote: "It is a devastating, heavily documented, relentless attack upon human carelessness, greed, and responsibility." Many readers did not separate Carson's specific message about pesticides from her general views about the environment, the economy, and ethics.

PROBLEM

Consider the relationship between the specific problem of pesticide use and the general problem of control of nature. Does either one necessarily imply the other? How would different readers interpret Carson's claims, based on how they perceived the problem on each of these two levels?

THE STORM FROM *SILENT SPRING*

The publication of *Silent Spring* in 1961 generated intense controversy. Chemical manufacturers responded to Carson's book in a way that reflected their interests. They said its conclusions were flawed, though they rarely addressed the results of specific studies that Carson cited. They suggested that the agricultural system and national economy would be crippled without pesticides of any kind. At the time, the United States was in a "Cold War" with the Soviet Union, and the industry cast the book in a way that drew on public fears of communism.

You might expect that a news magazine would be more likely to be objective. *Time*, however, informed readers of Carson's "oversimplifications and downright errors." Scientists and other technically informed persons, it reported, considered the book "unfair, one-sided, and hysterically overemphatic. Many of the scary generalizations—and there are many—are patently unsound." *Time*'s review praised

Carson's motives while trivializing her work: "Many scientists sympathize with Miss Carson's love of wildlife, and even with her mystical attachment to the balance of nature. But they fear that her emotional and inaccurate outburst in *Silent Spring* may do harm by alarming the nontechnical public, while doing no good for the things that she loves." Here, *Time* made a judgment on behalf of the reader about the relative authority of Carson versus others with technical credentials. What would the readers of *Time* "know"—or think they knew? How many of them do you think would have read Carson's work itself?

Most importantly, perhaps, critics sought to discredit Carson herself. They portrayed her—significantly—as a woman, "Miss" Carson, swayed by emotion: she was a "bird lover," a "cat lover," a "fish lover," a "priestess of nature"; she was a "hysterical" woman. Such epithets were misleading caricatures, of course. Yet given the cultural images of women at the time, they could raise substantial doubts about Carson's credibility. The implication was that someone who might see the emotional dimension of information could only be wrong scientifically. They also implied that a woman could be neither a spokesperson for nor authority about science. These critics sought to remove Carson's voice from the debate. Imagine how someone whose ability to present evidence objectively is itself at issue could deal with such criticism.

The book also elicited extensive public reaction. Readers expressed themselves in a "tidal wave" of letters to Carson and to newspapers, Congressmen, and government agencies. Their outrage about health and nature largely reflected the emotional dimension of Carson's writing. The book became the subject of many newspaper

J. W. Taylor in *Punch*. Copyright © Punch Publications.
"This is the dog that bit the cat that killed the rat that ate the malt that came from the grain that Jack sprayed"

FIGURE 17.3 Cartoon inspired by Carson's work. *Source:* J. W. Taylor in *Punch*. Copyright © Punch Publications.

editorials, columns, and political cartoons (Figure 17.3). How much of the response, do you suppose, was based on careful evaluation of the scientific evidence?

After *Silent Spring*, President John F. Kennedy asked his scientific advisors to examine Carson's claims. They largely confirmed her conclusions, giving them wider public authority. In the decade that followed, the U.S. Congress passed landmark legislation to regulate the use of pesticides (and to ban some, like DDT). New laws also set standards for clean air and clean water, protected endangered species, and established the Environmental Protection Agency. A mere three decades later, *Silent Spring* would be ranked as one of the 25 most influential books in human history, along with the *Bible*, Shakespeare's works, and Darwin's *On the Origin of Species*. Carson's effort to inform the public about the biology of pesticides had transformed society.

Carson would reflect much later that "some awareness of this problem has been in the air, but the ideas had to be crystallized, the facts had to be brought together in one place." Carson clearly tapped into environmental sentiments that were already emerging or latent in the populace. Still, many biologists had tried during the 1950s to alert the public—and had failed. The effects of DDT had not changed since the mid-1940s, when the earliest articles by entomologists and government officials appeared. Carson's influence was unique.

An ecologist, Murray Bookchin, published a book of similar if not wider scope a mere six months prior to *Silent Spring*. But Bookchin admitted a decade later that Carson's "superb prose" had been able to captivate a large audience in a way that he had not. For this and other reasons, Carson's book was a seed crystal and a catalyst. The image of a "silent spring" served, like a flag on a battlefield, as a rallying point for what soon became a popular environmental movement. It was a new emblem, as powerful as the images of aldrin and DDT had once been for the promise of chemical technology.

☐ EPILOGUE

"The" problem of pesticides may be viewed in many ways. Carson chose to focus specifically on how certain chemical pesticides were used and generally on how humans viewed nature and tended to control it. Carson's alternative was biological control.

Other views are possible. The problems posed by DDT, for example, are quite specific. Not all pesticides persist in the environment for long periods after spraying, thereby endangering other local wildlife. Nor do they all concentrate in the food chain. This occurs only when the compound is stored in some tissue and the tissue is eaten by the predator. In addition, DDT affects many organisms, not just one particular group of insects. Accordingly, many chemists since *Silent Spring* have searched for alternative synthetic chemicals that are biodegradable and species–specific.

Alternatively, you might note that we use pesticides only when plants cannot resist insect attacks themselves. Some individual plants are more susceptible than others in the same species. The prospective solution given this view is more long term: breed more resistant strains of crops. Some agronomists have considered this as another partial solution. They also recognize, however, that pests can evolve as well. Any new capacity to resist insects may be only temporary (see Chapter 13).

Finally, you could see the need for pesticides in terms of crop husbandry. That is, agriculture is often based on growing a uniform stand of one crop. This monoculture style of farming makes sowing and harvesting easier, but it also allows pests to spread rapidly. The vulnerability of monocultures to pests, recall, is one reason pest control is necessary. In many nonindustrialized nations, though, crops are often mixed on the same land and harvested separately. Where there is no monoculture, pests pose fewer problems. Thus, to solve the problem of pesticides, you would *dis*solve the need for them.

PROBLEM

Identify whether each of these four alternatives solves both the specific problem and the general problem that Carson introduced in *Silent Spring*.

On the twenty-fifth anniversary of the publication of *Silent Spring*, in 1987, two friends and colleagues of Carson assessed the status of pesticides in the United States. Pesticide use in agriculture had been strongly curtailed. But groundwater was still being contaminated by chemical runoff. One study sponsored by the National Academy of Sciences compared sources of pesticides and herbicides. Average use on farmland was less than 2 pounds per acre. Use on residential lawns, however, where homeowners applied them to control weeds, averaged 10 pounds per acre. While *Silent Spring* had ushered in major changes, the question of who knew about the biology of pesticides and who did not was still relevant. Vestiges of the challenge that Carson faced in informing the public still seem to linger.

QUESTIONS AND ACTIVITIES

1. What does this case show about the following aspects of doing biology?
   — experts versus nonexperts
   — the individual versus collective nature of science
   — the role of individual motivation
   — the interaction between emotion, values, and research
   — communication and writing skills
   — the role of personal background in interpreting a scientific problem
2. Reconsider the problems about public communication of scientific information that you identified in the problem on page 188, now knowing the history of *Silent Spring*. How would you address the remaining problem of informing residential users about pesticides?
3. How was Carson's use of emotive images and language appropriate or inappropriate in informing the public?
4. Discuss whether Rachel Carson, given her unique position and abilities, had a duty or moral responsibility to write about pesticides. More generally, to what degree can society justifiably expect an individual biologist to communicate the results of his or her research to the public when the findings have broad social significance?

5. Devise a strategy of informing the public that might have won support from the chemical industry by drawing on their interests.
6. In 1962, a television news documentary presented interviews with Carson along with industry and government officials who disagreed with her. What criteria would the typical viewer have used to assess the relative credibility of each speaker? How would a news reporter have been able to assess their credibility? More broadly, how does someone who is not an expert know who is (see also Chapters 12 and 16)? Discuss how you might organize public decision making on scientific issues to take advantage of expertise while controlling bias.
7. Comment on the claim in Carson's epigram that we should view nature "appreciatively" rather than "skeptically and dictatorially"? In what ways, if any, is ecological knowledge needed to make this value judgment? What is the relationship between science and values in this case?

SUGGESTED READING AND VIEWING

Brooks, P. 1972. *The House of Life: Rachel Carson at Work.* Boston: Houghton Mifflin.

Carson, R. 1961. *Silent Spring.* Boston: Houghton Mifflin. Reprinted 1991.

McCay, M. A. 1993. *Rachel Carson.* New York: Twayne Publishers.

McKibben, B. 1989. *The End of Nature.* New York: Anchor Books.

McPhee, J. 1989. *The Control of Nature.* New York: Noonday Press.

"Rachel Carson's *Silent Spring.*" 1994. From *The American Experience* series. WGBH (Boston).