

Silent Spring



INTRODUCTION

BRIEF BIOGRAPHY OF RACHEL CARSON

Rachel Carson was an important figure in modern American environmentalism, whose work is sometimes credited with creating the grassroots movement that led to the establishment of the Environmental Protection Agency (EPA). She grew up on a farm in Pennsylvania, and then earned a master's in zoology from Johns Hopkins University in 1932, while working in research labs to earn money for tuition. When her father's sudden death left her without the time or funds necessary to continue on to a doctorate, Carson found a job with the U.S. Bureau of Fisheries, later known as the Fish and Wildlife Service. While there, she began writing and published articles in newspapers and magazines. The first books that earned her fame were written on the topic of marine biology. With their success, she was able to quit her job and focus on writing full time, and her interests began to shift more toward conservation. She began work on *Silent Spring*, her most lasting legacy, in 1958, gathering research and soliciting contributions from major experts. The process of writing the book was slowed by family issues, and then by sickness when Carson was diagnosed with breast cancer. She died of a heart attack two years after its publication, in 1964.

HISTORICAL CONTEXT

Carson's decision to report on the dangers of pesticides was a result of a fire ant eradication program in 1957 in which DDT mixed with fuel oil was sprayed on private and public land in Long Island. After its publication, *Silent Spring* inspired a grassroots political movement that led to the creation of the Environmental Protection Agency in 1970 and a ban on DDT in 1972.

RELATED LITERARY WORKS

Silent Spring is part of a tradition of nature writing that has its American roots in writers like Henry David Thoreau, author of *Walden Pond* and key figure in the transcendentalist movement, and John Muir, whose popular written accounts of the American West and public campaigning were instrumental in the founding of America's National Park Service. Her conservationist ideas were prefigured by contemporaries like Aldo Leopold ([A Sand County Almanac](#), 1948), whose work brought public attention to the values of environmentalism.

KEY FACTS

- **Full Title:** *Silent Spring*

- **When Written:** 1958-1962
- **Where Written:** Silver Spring, Maryland
- **When Published:** 1962
- **Genre:** Environmental Science, Nonfiction
- **Setting:** United States
- **Antagonist:** Uncontrolled pesticide spraying
- **Point of View:** Carson narrates in the first person

EXTRA CREDIT

Influencing Al Gore. Al Gore, former vice president and major spokesperson for public awareness of climate change, cites Rachel Carson's book as one of the most important reasons that he became involved with environmental interests.

Undersea Love. Carson's first job as a copywriter with the U.S. Bureau of Fisheries was writing for a short weekly radio broadcast entitled "Romance Under the Waters."



PLOT SUMMARY

In *Silent Spring*, a book that is often viewed as a landmark work of environmental writing, Rachel Carson turns her attentions to the potentially harmful effects of pesticides on the environment – particularly those pesticides, including DDT, that were being administered via aerial spraying in an attempt to control insect populations on a massive scale. In many ways, *Silent Spring* served as a public warning, gathering expert opinion on the dangers of this increasingly destructive practice.

In addition to the actual accounts of contamination that she describes, Carson's book also contains an overarching argument about the proper relationship between man and nature that contributed to the growth of the "deep ecology" movement regarding the interconnectedness of all living things and systems. After a parable that begins the book by envisioning a future in which **silence** reigns over the world after pesticides have wrought their ultimate destruction on the environment, Carson lays out her basic thesis. In an interconnected world, she argues, man's newfound power to change his environment needs to be wielded with extreme caution if we are to avoid destroying the very systems that support us.

To begin her project of public education, Carson outlines the major families of pesticides in use, referring to them as "biocides" since their effects are actually not specific to insects. Having laid out her basic conceptual framework and identified the chemicals in question, Carson breaks down the effects of

these pesticides into their component parts, examining different sections of the natural world from the water to the soil, and from plants to birdlife. She marshals an impressive range of anecdotal and statistical evidence, quoting from expert testimony along the way, to show that pesticides are much deadlier than their manufacturers will admit, and that within nature they will accumulate and interact to create effects that are difficult to foresee – particularly given that the United States provided almost no budget for research into the topic.

Next, she examines a few particularly disastrous spraying programs and then pivots to focus directly on a discussion of pesticides' effects on humans. She sharply criticizes the "cheerful" marketing of poisonous pesticides, reveals the near constant presence of such chemicals in the food people consume, and outlines the lack of regulation of these chemicals, and then details the data that suggests these chemicals are cancer-causing. To conclude, she argues that not only are pesticides dangerous to the environment and humans, but that they also have not in fact succeeded in their mission; pests often rebound massively after spraying, once nature's built in system of checks and balances has been disrupted. In addition, many insects are developing resistance to new pesticides in a dangerously accelerating pattern resembling an arms race.

The only way forward, Carson suggests, is to emulate the strategies of natural systems, pursuing biological, rather than chemical, controls wherever possible – such as identifying and deploying predators of pests rather than just trying to kill the pests with chemicals.

Given all of the information she presents, Carson argues that the only prudent way forward is to forego flashy, arrogant pursuit of the 'easy' solution and humbly return to the 'road less traveled by,' letting go of the conceit that nature only exists to serve the interests of humanity.



CHARACTERS

MAJOR CHARACTERS

Rachel Carson – The author of *Silent Spring*, and an important figure in modern American environmentalism. Her work is often credited with spurring the movement that led to the creation of the EPA (Environmental Protection Agency) and the banning of the pesticide DDT because of its impact on the environment and animals higher up the food chain.

Alfred Koebele – An entomologist-explorer who traveled to South America in search of a predator for the cottony cushion scale that threatened California citrus. He returned in 1888 with the vedalia beetle, a successful example of biotic control – the control of pests through the introduction of a predator of that pest, rather than through chemical means.

MINOR CHARACTERS

Paul Shepard – An American environmentalist whose writings urged a return to ancient relationship to the natural world. He was an influential figure in the development of the deep ecology movement.

Dr. W.C. Hueper – An early pioneer in occupational medicine, he researched the effects of environmental agents on the development of cancer.

Gerhard Schrader – A German chemist who specialized in developing new insecticides to increase production and decrease hunger in the world. His discoveries also led to the development of nerve gas used as a weapon in World War II.

Professor Rolf Eliassen – A professor at the Massachusetts Institute of Technology (MIT) who testified before a congressional committee on the unknown composite effects of chemicals mingled together in streams.

The Borgias – An infamous dynastic family from the Italian Renaissance, many of whom became Popes, and who were widely believed to have engaged in poisoning to combat rival families.

Justice William O. Douglas – A Supreme Court Justice who holds the record for the longest term in history at nearly 37 years. He was a lifelong advocate for environmental issues and wrote a glowing review of Carson's book upon its publication.

John Mehner – A graduate student at Michigan State University who, along with his adviser Professor George Wallace, documented the effects of spraying for Dutch elm disease on robin populations on campus.

Owen J. Gromme – The curator of Birds at the Milwaukee Public Museum.

Charles Broley – A retired banker from Winnipeg who achieved ornithological fame after banding more than 1,000 eagles on the coast of Florida from 1939-49.

Dr. James DeWitt – A researcher for the United States Fish and Wildlife Service whose work with DDT predicted the chemical's impact on the fertility of eggs of birds exposed to it.

Dr. Philip Butler – A member of the Bureau of Commercial Fisheries.

Robert Cushman Murphy – A world-famous ornithologist who sought an injunction against DDT spraying on Long Island in 1957.

Dr. Otis Poitevint – A veterinarian from Bainbridge, Georgia who voiced concerns during the massive insecticide campaign against fire ants in the American South.

The FDA – The FDA (Food and Drug Administration) is a federal agency tasked with overseeing the safety of food; they have jurisdiction over goods that are trafficked via interstate commerce.

Eugene Rabinowitz – A chemist cited by Carson in relation to his research into energy production on a cellular level.

Sir Percivall Pott – A physician in eighteenth century London who first proposed the link between environmental agents – soot, in the case of chimney sweeps – and cancer.

Dr. Malcolm Hargraves – A doctor in the Hematology Department at the Mayo Clinic who reported links between blood disease and exposure to toxic chemicals, including DDT.

Professor Otto Warburg – A German biochemist at the Max Planck Institute of Cell Physiology who studied cell oxidation and proposed one potential origin for cancer.

Charles Darwin – An English naturalist and geologist from the nineteenth century whose theories of evolution and natural selection, proposed in his book *On the Origin of Species*, revolutionized our understanding of biology.

Dr. Charles Elton – A British scientist specializing in the study of animal populations.

Dr. Briejer – Director of the Plant Protection Service in Holland who urged that pesticides be used cautiously after observing that insect populations were growing increasingly resistant to the chemicals.

Robert Frost – An iconic American writer whose poetry is often set in rural parts of the Northeast. Carson makes reference to his famous poem “The Road Not Taken.”

Dr. Edward Knipling – Chief of the United States Department of Agriculture’s Entomology Research Branch. He developed the male sterilization technique for pest control.

Dr. A.D. Pickett – A scientist who Rachel Carson highlight as a pioneer of natural methods of pest control, as well as precisely applied, gentler chemical pesticides. He denounces indiscriminate spraying, describing it as a route to crisis after crisis.

fragility of these complex systems, whose checks and balances are still beyond human comprehension.

Humans, argues Carson, are arrogant to presume that they can intervene in this system without disrupting its careful balance, and to assume that nature exists for human benefit alone without an inherent value or worth of its own. When humans treat nature in this arrogant way, such as in the case of indiscriminately applied pesticides, they are not only foregoing and in some cases crippling the more effective insect control methods that nature provides, they are also unleashing an unpredictable chain of destruction that will open themselves up to unknown dangers. For instance, Carson shows how the blanket spraying of large swathes of wilderness, or even of farms, is destructive beyond any initial death toll. *Bio-magnification*, a process in which concentrations of pesticide are accumulated in progressively higher rates at each stage of the food chain, can lead to unpredictable consequences in species that were not the original target of the attack.

As part of the natural system ourselves, Carson implies, humans are vulnerable to anything that will disrupt the balanced system of connections carefully calibrated over millennia. Disrupting this ancient balance by intervening at a massive scale over short periods of time is shortsighted, and the urge to do so displays a dangerous lack of humility on the part of humanity.



THE PRECAUTIONARY PRINCIPLE

Although the term did not yet exist when Rachel Carson published *Silent Spring* in 1962, a major component of its argument conforms to the spirit of *the precautionary principle*, which suggests that when a risk is unknown – because not enough research has been carried out, perhaps – the prudent course of action is always to hedge against potentially dangerous effects by slowing or even halting progress until more is known.

Although Carson consistently aims to demonstrate that there is in fact a well-known risk to using pesticides on a large scale, her greatest indignation stems from accounts of state and federal bureaucratic agencies that proceeded with plans for massive aerial spraying despite warnings and protests about unknown dangers. The budget for research at these institutions is pitifully small, notes Carson, as is the staff at the FDA tasked with enforcing mandatory limits on pesticide residue on foods, such as vegetables or other crops, consumed by humans. The little research into effects on the environment that had been done was mostly conducted by independent biologists from a ‘post-mortem’ perspective; that is, it assessed damage after spraying had already occurred. Many of Carson’s accounts are cobbled together from sources such as these, letters from locals, or cases where environments were carefully monitored before spraying as a result of other interests in the



THEMES

In LitCharts literature guides, each theme gets its own color-coded icon. These icons make it easy to track where the themes occur most prominently throughout the work. If you don’t have a color printer, you can still use the icons to track themes in black and white.



THE INTERCONNECTEDNESS OF LIFE

Underpinning Rachel Carson’s warning against the use of pesticides is a deep awareness of life as a complex system, often referred to as “deep ecology,” in which organisms and environment are connected in a fluid but carefully balanced ecology. As she writes in chapter four, “in nature nothing exists alone.” Much of *Silent Spring* is devoted to analyzing different aspects of this ecology, from soil to plant life, and from the water table to the world of migratory birds. A wealth of anecdotes related to each demonstrates the

area.

There are a multitude of these stories, which were uncovered too late to prevent the tragedies they describe from recurring, and *Silent Spring* seems to be an attempt to gather them together into one narrative that could effect change. Carson gives voice to this repeated tale of far-ranging destruction as a means of warning readers about the potential risks of pesticides, and to urge caution in the face of consequences that are often long-term and difficult to predict.



PAST, PRESENT, FUTURE

Beginning from its opening chapter, “A Fable for Tomorrow,” *Silent Spring* is framed by a mixture of nostalgia for an idealized past and urgent warning against a particular vision of the future, hints of which could already be seen in certain aspects of Carson’s world of the early 1960s.

In the book, Carson completes a thorough survey of current spraying practices and their massively detrimental effects on local ecosystems, but her most dire warnings come in the form of a vision of the possible future effects of these chemicals on both animals and humans. There is a real sense that, if unchecked, pesticide usage could lead to the extinction of several treasured species of fish and birds, including the United States’ patriotic symbol of the bald eagle.

Carson’s discussions of the effects of pesticide use on fish and bird populations convey a sense that there isn’t any reason to think that such effects won’t continue up the food chain all the way to humans, spreading sterility and mutations from one generation to another. Carson emphasizes that the effects of these chemicals can remain latent and unobserved until the development of cancer decades later, which makes their present impact difficult to measure. This, she argues, is all the more reason to take seriously the effects of pesticides on animal communities with greater sensitivity and shorter life spans. Another aspect of Carson’s apocalyptic vision for the future is ever more resistant insect populations, and an accompanying evolution of ever more potent poisons, resulting in a kind of “arms race” in which, to kill pests, humans wind up killing much much more.

Paired with Carson’s vision of a dangerously contaminated future is a real sense of her nostalgia for a pristine past, before this new era of chemical pesticides. Poetic passages describing the diversity of roadside growth missed by tourists or the birdsong of early spring capture this idealized past – a simpler, slower time. This tendency is common among nature writers and environmentalists, although some thinkers who have followed after Carson have expressed worries that it could perpetuate a false divide between what is considered ‘nature’ and what is not.

One danger of creating a divide between man and nature is

that it contributes to the narrative that says that one must win over the other: that progress cannot coexist with conservation. It is important, argue contemporary environmental thinkers, to recognize that man is *part* of nature. And, in the book, Carson does seem ultimately to balance the need for development and progress alongside an appreciation for the complexity of systems grown over millennia.



PUBLIC EDUCATION AND RESPONSIBILITY

Carson’s main goal in writing this book was to educate the public about the dangers of unchecked chemical pesticide use, and awareness of the issue grew massively after the book’s publication.

One tactic used by Carson is a comparison of the dangers of pesticides to those of nuclear radiation, which had a much higher public profile in the 1960s (given the dropping of the atomic bombs in World War II just two decades earlier). Because pesticides had the Department of Agriculture’s stamp of approval and were marketed ‘cheerfully’ in grocery stores, many consumers were unaware of the potentially harmful effects of pesticides. Home gardeners routinely used herbicides and pesticides that would have been considered poisons twenty years previously, with the assumption that they were harmless to humans.

In fact, the notion of a ‘safe level’ of pesticide residue is inherently flawed, argues Carson, since the effects of pesticides have been shown to be cumulative and to change when used in combination with other substances. The idea of an acceptable tolerance level – even if it were adhered to by farmers and verified by a strengthened FDA – is a dangerous one, because it provides a sense of security that is demonstrably false and weakens public interest.

Carson often cites accounts from local citizens of affected areas who express concern or sadness at the results of pesticide spraying. This tension between locals and public authorities, and between what is seen on the ground by residents on the one hand and what government agencies claim to be true on the other, is a major part of the battle over public education and responsibility as Carson sees it. One of the most important questions at the heart of *Silent Spring* concerns this responsibility. Who has the right to make a decision about chemical usage, when widespread spraying seems to affect everyone and everything in ways that are not yet fully understood?

Carson seems to conclude that no one should have the authority to choose to use a method that has been shown to be so destructive—or even one that *might* be destructive. She argues that, if anything, the ultimate authority on pest controls ought to be nature itself; she lists a series of biological methods as alternatives to pesticides, all of which take their inspiration

from the evolved processes of natural ecosystems. Nowadays, contemporary environmentalists with an even wider view of the dangers of invasive species than Carson held would likely argue that Carson's enthusiastic support of biotic controls, including the importation of non-native predators and parasites to control pests, could *also* be disruptive to the careful balance of established ecosystems.



A NEW ERA OF MAN

A major theme of Carson's argument is that we have entered a new period in history, in which man has the power to change his environment on an unprecedented scale. Geologists have since proposed the term *anthropocene* – which means, literally, the “age of humans” – to describe this new era. Because of its newfound power, argues Carson, humanity is at a crossroads.

On the one hand, the increasing acceleration of technological development seems to be leading man toward his own doom. Whereas in the past, humans strove with admirable results to eliminate pathogens that were discovered to transmit disease, today we are populating our daily lives with contaminants and mutagens whose negative and cancer-causing effects are barely understood. Moreover, nearly every case of destructive pesticide use that Carson describes can be seen as a chronicle of man's foolhardy wish to control nature, from elimination of the sagebrush from the Western landscape to eradication of the fire ant from the American South. As Carson explains, these projects are inevitably rushed and ill-conceived, and ultimately backfire; disease-carrying insects evolve resistance to pesticides, destruction of natural predators actually leads to an increase in the population of the targeted species, or the elimination of one part of the system fatally disrupts another.

On the other hand, Carson suggests, we could choose to slow down, regard our place within the complexity of nature with the humility it deserves, and make use of other methods. Carson lists a variety of different techniques inspired by nature that are either in use or development- they are often cheaper, more effective, and less destructive than an indiscriminate, blanket chemical approach.

Another feature of this new era of man is that, given all of the changes to earth's environment since the beginning of the industrial revolution, every corner of the planet has been touched by man's efforts. This means that there are no pristine places left; we are all affected by whatever ways we choose to change our environment. Carson cites Alaskan Eskimos as one possible exception, but only to dash this hope by showing that there, too, evidence of contamination has arrived. This means that both the consequences of and responsibility for choices that we, as a species, make about the use of chemicals, radiation, etc. are inescapably global and long term.



SYMBOLS

Symbols appear in **teal text** throughout the Summary and Analysis sections of this LitChart.



SILENCE

Silence plays an important symbolic role in Carson's book. Its significance is introduced in the opening chapter, as Carson envisions a small town that is eerily silent, all of its natural life having been destroyed by a mysterious powder. In the book, silence comes to represent the death of nature, and the end of an idyllic past full of birdsong that accompanied the changing seasons. Through this symbol, Carson implies that if humans do not change the ways they act regarding their impact on nature, we will quickly find ourselves in a lonely, bare world where the beauty of the natural world has been irretrievably lost.



QUOTES

Note: all page numbers for the quotes below refer to the Houghton Mifflin edition of *Silent Spring* published in 2002.

Chapter 1 Quotes

☞ There was once a town in the heart of America where all life seemed to live in harmony with its surroundings. The town lay in the midst of a checkerboard of prosperous farms, with fields of grain and hillsides of orchards where, in spring, white clouds of bloom drifted above the green fields.

Related Characters: Rachel Carson (speaker)

Related Themes:  

Page Number: 1

Explanation and Analysis

This passage comes from the very beginning *Silent Spring*. Carson presents a nostalgic portrait of life in a small American town, which is in perfect harmony with nature. In this first chapter, Carson offers a fable designed to create an image of the apocalyptic present and near future that are disrupting this idyllic past. So what does Carson's ideal vision look like?

The idyllic past that she describes here has as its most important characteristic a sense of interconnectedness, since everything lives "in harmony with its surroundings." The town is only one part of the landscape, nestled "in the midst" of a productive, beautiful, natural setting. This place

is "prosperous" as well as beautiful, since an important part of the pragmatic Carson's message is aimed at a broader public concern with economic as well as environmental issues. She aims to show the interconnectedness of these issues as well, outlining the importance of a better environmental ethic for preserving the prosperous future of America.

Chapter 2 Quotes

☞ The history of life on earth has been a history of interaction between living things and their surroundings. To a large extent, the physical form and the habits of the earth's vegetation and its animal life have been molded by the environment. Considering the whole span of earthly time, the opposite effect, in which life actually modifies its surroundings, has been relatively slight. Only within the moment of time represented by the present century has one species, man, acquired significant power to alter the nature of his world.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 5

Explanation and Analysis

Here Carson frames humanity's role in the world according to the planet's long history, and offers an important perspective on the newfound power of mankind. For millennia, she explains, life has been shaped by its environment, as diverse species have developed in response to environmental pressures since the beginning of life on earth. Now, though, she argues that we are entering into a new phase in life's relationship to the environment. Because humanity has risen so quickly to a position of immense power, living things - humans, that is - now have a real impact on the environment, shaping a world that has shaped life for so long. This new era is what atmospheric chemist Paul Crutzen later named the "Anthropocene" - the age of man, when humanity has begun to change the environment on a scale equivalent to a geological force. How humanity chooses to wield this force will determine the future of our species, as well as the future of the environment that sustains all life on earth, since history and biology show us that all life is interconnected, each species dependent on the diverse web of fellow species with which they share the planet.

☞ Given time - time not in years but in millennia - life adjusts, and a balance has been reached. For time is the essential ingredient; but in the modern world there is no time. The rapidity of change and the speed with which new situations are created follow the impetuous and heedless pace of man rather than the deliberate pace of nature.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 6

Explanation and Analysis

In this quote, Carson drives home the danger associated with this new age of the world, in which mankind suddenly has the power to enact massive changes to the planet's environment. By considering the past, from a biological and historical perspective, Carson provides an appreciation of the fact that (sometimes destructive) change is a necessary and manageable part of life on earth. The environment has changed before, and life has adapted itself to the new status quo in each case, evolving to suit the change in environment. What makes the current - and impending - changes different, Carson warns, is that they are happening on a radically different time scale.

Past changes, which were the result of natural shifts in the earth's climate, happened at the "deliberate pace of nature," but now they are barreling forward at an "impetuous and heedless" pace, thanks to mankind's powerful influence. In her choice of adjectives to describe humanity, Carson implies that mankind is a childish force, immature in its appreciation of the age-old earth and its environment. As a result of man's immature actions, which have robbed the earth of the time it needs to adapt to change, evolution cannot properly function to ensure the survival of life on earth.

☞ Some would-be architects of our future look toward a time when it will be possible to alter the human germ plasm by design. But we may easily be doing so now by inadvertence, for many chemicals, like radiation, bring about gene mutations. It is ironic to think that man might determine his own future by something so seemingly trivial as the choice of an insect spray.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 8

Explanation and Analysis

In this quote, Carson warns that mankind, in his arrogance, may be unknowingly altering his own genetic design through the use of chemical pesticides. That a “seemingly trivial” action taken by the government could have such widespread impact is precisely the reason why intensive precautions are necessary; humans now have the power to change their environment, and themselves, at a rate that has never been seen before. In order to avoid making changes that do more harm than good, measures of caution must be enacted at every level of decision-making.

Here Carson makes the link to nuclear radiation, in her time a more well-known issue than pesticides, and one which inspired fear in many Americans. She belittles the chemical engineers, shaming them for messing with forces, like radiation, that they do not understand, overconfident in their self-assessment as “would-be architects of the future.” She points to the unseeable effects of pesticide, which have not been sufficiently researched, in order to inspire fear - in her mind a completely justifiable fear - in her reader, urging them to protect the future by slowing the reckless pace of chemical development.

☛ ...idealizes life with only its head out of water, inches above the limits of toleration of the corruption of its own environment...Why should we tolerate a diet of weak poisons, a home in insipid surroundings, a circle of acquaintances who are not quite our enemies, the noise of motors with just enough relief to prevent insanity? Who would want to live in a world which is just not quite fatal?

Related Characters: Rachel Carson (speaker)

Related Themes:     

Page Number: 12

Explanation and Analysis

In this quote, Carson attacks the notion that there can be an “acceptable level” of poison in the environment, or in our food. In Carson’s view, choosing a life that is just at the threshold of fatal poisoning seems absurd. She envisions the modern race toward chemical development as a rising flood, which has left humanity with “only its head out of water,” struggling to survive in an environment where each interconnected organism is vulnerable to the contamination

of any other. Is a merely ‘tolerable’ environment what we ought be pursuing as a species?

Carson goes on to describe the dullness of an “insipid,” poisoned, reduced nature, appealing to a nostalgic desire to preserve the environment as a beautiful place in which to live and thrive. In the same sentence, she evokes the danger to human health by referencing our “diet of weak poisons,” and speaks out against the relentless forward motion of a bustling drive toward progress by demonizing the constant “noise of motors” as a road to insanity. She is asking the public - making use of repeated questions, all referencing the same idea of a “not-quite-fatal” level of some negative force - to consider their responsibility in shaping the coming years, so that they might help prevent what she paints as a particularly bleak possible future.

☛ If the Bill of Rights contains no guarantee that a citizen shall be secure against lethal poisons distributed either by private individuals or by public officials, it is surely only because our forefathers, despite their considerable wisdom and foresight, could conceive of no such problem.

Related Characters: Rachel Carson (speaker)

Related Themes:    

Page Number: 12

Explanation and Analysis

Carson makes her argument clear - all Americans ought to be protected against the poison of pesticides. By invoking the Bill of Rights, Carson suggests that this protection is tantamount to the most fundamental of American freedoms, a basic expectation of what it means to live in this country. This argument makes the link between public health and environmental issues perfectly explicit. At the same time, by referencing the Bill of Rights and those forefathers who wrote it, and suggesting that even they - “despite their considerable wisdom” - were unable to foresee this day, when the actions of the government would poison its own nation, Carson offers a powerful reminder that the pace of development has outstripped reason and caution. Pesticides, argues Carson, represent a threat so entirely new that even a few hundred years ago - a relatively short time in all of human history, and a blip in geological time - they would have been inconceivable. Surely such an inconceivable threat deserves due consideration before being deployed, suggests Carson. More testing, at the very least, is absolutely necessary before pesticides as a large scale method of insect control can be considered, especially

when it seems very likely that pesticides could harm the health of an entire nation.

☞ We are rightly appalled by the genetic effects of radiation; how then, can we be indifferent to the same effect in chemicals that we disseminate widely in our environment?

Related Characters: Rachel Carson (speaker)

Related Themes:  

Page Number: 37

Explanation and Analysis

Carson begins to make a link that will continue to crop up throughout the book, comparing the dangers of pesticides to the more widely known dangers of radiation and nuclear armament. By making this link, Carson sets out her goal of educating the public about a different but equally troubling consequence of man's rapid technological development. The issue of radiation had wider public support as a public health issue already, and it offers readers a sense of how serious the threat might be. Activists had been advocating the position that nuclear disarmament was a responsibility of mankind, since radiation poisoning threatened the whole world, and Carson wanted to create a similar sense of collective responsibility when it came to pesticides.

This link also falls into line with the precautionary principle, which suggests that unknown dangers ought to be thoroughly explored before any action that might set them off is set in motion. This principle had been part of the public dialogue around the unknown effects of radiation poisoning, and Carson suggests it apply in the case of pesticide poisoning as well.

☞ When sportsmen of an area want to 'improve' fishing in a reservoir, they prevail on authorities to dump quantities of poison into it to kill the undesired fish, which are then replaced with hatchery fish more suited to the sportsmen's taste. The procedure has a strange, Alice-in-Wonderland quality.

Related Characters: Rachel Carson (speaker)

Related Themes:  

Page Number: 50

Explanation and Analysis

Carson examines the practice of sport fishermen who kill "undesired" fish and replace them with fish raised in a

hatchery—species that they are more interested in fishing for. Do these sportsmen have the right to exert such sweeping control over the local ecosystem, killing native species in favor of those they find more "desirable?" Furthermore, Carson asks, what are the unintended health consequences - for the other species living in the ecosystem, but also for the people in the surrounding area - of dumping pesticide into the water, since the water system is so entirely interconnected?

Carson portrays this operation as an absurd one, like something out of a fairy-tale book. She compares it to *Alice's Adventures in Wonderland*, a book full of absurd contradictions and arrogant characters convinced that their sometimes ruthless actions are justified merely because they satisfy some momentary and arbitrary desire. The fact that these sportsmen (and the companies and authorities that cater to them) have the power to craft a lake that complies to their desires, argues Carson, does not give them the right to exert that power in such a potentially dangerous way.

Chapter 6 Quotes

☞ Our attitude toward plants is a singularly narrow one... The earth's vegetation is part of a web of life in which there are intimate and essential relations between plants and the earth, between plants and other plants, between plants and animals. Sometimes we have no choice but to disturb these relationships, but we should do so thoughtfully, with full awareness that what we do may have consequences remote in time and place.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 63

Explanation and Analysis

Carson again reminds her reader of the interconnectedness of all life, and of the connection between life and its environment. As she will show in this chapter, affecting any plant has effects on the other living beings in its ecosystem, plant and animal alike. She describes the relationships between these webs of living beings as "intimate and essential" to give a sense of how closely intertwined these species can be, such that disturbing one has terrible effects on another. For this reason, human agencies that decide, through the use of pesticides, to attack a single species that has been singled out as a "weed" - for some reason,

aesthetic or otherwise, an undesirable plant from the human perspective - are playing with systems they do not understand, attempting to exert control without considering the delicate interdependences of natural ecosystems. If there is a reason to intervene in these systems - and there may be, Carson admits - the choice to do so must be weighed with the utmost caution, since its effects will be nearly impossible to forecast, and may not even be visible for some time.

☛ The chemical weed-killers are a bright new toy. They work in a spectacular way; they give a giddy sense of power over nature to those who wield them, and as for the long-range and less obvious effects— these are easily brushed aside as the baseless imaginings of pessimists. The 'agricultural engineers' speak blithely of 'chemical plowing' in a world that is urged to beat its plowshares into spray guns.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 68

Explanation and Analysis

In this quote, Carson criticizes the pesticide makers' blind faith in the power of their technology to solve what they see as the world's problems. As she has in the past, Carson uses language that casts these 'engineers' as childish, comparing their pesticides to a "bright new toy." In an era where man has the power to influence nature on a wide scale, these engineers are, in Carson's view, drunk on power, "giddy" with the sense of control that they have - even if this control is an illusion.

Any criticism of the power-plays of these engineers is brushed aside, since criticisms are based often in effects that are long term or difficult to observe - which is why Carson has written this book to catalogue those effects, and educate the public, convincing them that precaution in the face of the unknown is the only morally acceptable position. She twists an old image from the Bible, of an idealized, peaceful future in which men will "beat their swords into plowshares," to emphasize that these pesticides are not tools of agriculture, but rather, in her view, weapons of war. She sees the childish actions of the engineers as having unleashed a war against nature that will ultimately lead to man's destruction.

☛ So, perhaps, it appears in the neat rows of figures in the official books; but were the true costs entered, the costs not only in dollars but in the many equally valid debits we shall presently consider, the wholesale broadcasting of chemicals would be seen to be more costly in dollars as well as infinitely damaging to the long-range health of the landscape and to all the varied interests that depend on it.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 69

Explanation and Analysis

In this quote, Carson asks her readers to consider the true cost of pesticides, beyond the simply monetary price of the chemicals. This question of "true cost" continues to be an important aspect of environmental economics, which makes the claim that pollution and other environmental harms are not properly considered in determining the price of a given action - since, on the one hand, these damages are difficult to forecast, and on the other, they are harder to quantify with a dollar number.

As Carson points out, the danger is that because the cost of chemicals alone is an easy number to conceive, the town councils and farmers who are responsible for making the decision to use pesticides in their community might be fooled into believing they are saving money by using chemicals, when in fact they are creating a debt that must be paid later - in clean up bills, crop loss, medical costs, and even repeated sprayings, since pesticides seem to be an ineffective method of long-term control. In addition to these hard-to-forecast economic costs, one must consider the loss of beauty, the potential loss of tourism that results, and - in Carson's appeal to small town American nostalgia - the loss of a way of life, as birds and fish die off.

☛ To the author of this paper, many of us would unquestionably be suspect, convicted of some deep perversion of character because we prefer the sight of the vetch and the clover and the wood lily in all their delicate and transient beauty to that of roadsides scorched as by fire, the shrubs brown and brittle, the bracken that once lifted high its proud lacework now withered and drooping. We would seem deplorably weak that we can tolerate the sight of such 'weeds', that we do not rejoice in their eradication, that we are not filled with exultation that man has once more triumphed over miscreant nature.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 72

Explanation and Analysis

In this quote, Carson defends the right of people to feel a sentimental attachment to the beauty of nature, objecting to its destruction on moral and aesthetic grounds. She has just finished describing a stretch of road with abundant greenery on either side, that was sprayed to prevent the spread of weeds - a choice that, to her mind, destroyed its natural beauty in the name of a false notion of control of nature with no real benefit. She describes the roadside before and after spraying with an emphasis on the contrast between the "delicate and transient beauty" of plant life to the depressing desolation of "withered and drooping" plants whose "proud lacework" has been destroyed. The image of lace urges the reader to consider the plants as something delicate and beautiful, crafted carefully over a long period of time and then thoughtlessly ruined.

Carson strongly condemns the decision to destroy these plants, and mocks those who would consider her, and others who feel the same way that she does, as "deplorably weak" for mourning the loss of their beauty. She refuses to join the ranks of those who rejoice in this destruction, and seems to presume that her reader will agree. She sarcastically undercuts this triumph of man over "miscreant nature" by showcasing the arbitrariness of what is classed as a "weed," and the brutality of the methods of control that take out vulnerable, helpless - and harmless - plants without discriminating between good and bad.

☛ Under the philosophy that now seems to guide our destinies, nothing must get in the way of the man with the spray gun. The incidental victims of his crusade against insects count as nothing; if robins, pheasants, raccoons, cats, or even livestock happen to inhabit the same bit of earth as the target insects and to be hit by the rain of insect-killing poisons no one must protest.

Related Characters: Rachel Carson (speaker)

Related Themes:    

Page Number: 85

Explanation and Analysis

Here Carson addresses the seeming impunity of pesticide users, who have been given the authority to spray wherever

and however they see fit. It is this philosophy, that the sprayers know best, which her book sets out to argue against. She uses language that casts the strategy of the pesticide users as a war against nature, careful to refer to their tools as spray guns, their chemicals as a rain of poison, and their actions as a crusade against which "no one must protest."

Because all life is interconnected, the casualties of this war are many, but the sprayers refuse to consider these losses, obsessed instead with maximizing profits via the destruction of certain insects or weeds. Carson's implied question is: where did these sprayers gain their unquestionable authority? Who is responsible for their choices? When did the need to prioritize killing insects become so great as to obscure all other considerations?

Chapter 8 Quotes

☛ Over increasingly large areas of the United States, spring now comes unheralded by the return of the birds, and the early mornings are strangely silent where once they were filled with the beauty of bird song. This sudden silencing of the song of birds, this obliteration of the color and beauty and interest they lend to our world have come about swiftly, insidiously, and unnoticed by those whose communities are as yet unaffected.

Related Characters: Rachel Carson (speaker)

Related Themes:    

Related Symbols: 

Page Number: 103

Explanation and Analysis

In this quote, Carson considers one of her chief examples of mankind's destructive influence: the erasure of native American birds from the landscape. She makes use of a key symbol in this book, silence, to spur the reader's concern for a future without birdsong, an image that evokes the loss of a pure joy that many may take for granted until it is too late; this is a description of the titular "Silent Spring." As usual, Carson selects words designed to maximize the effect of her warning - she describes an "obliteration" of "color and beauty and interest" that is sneaking "insidiously" across the nation, casting birds as the beautiful, innocent victims of an invisible, malignant threat.

Carson makes it clear here that her mission is to present the

image of this impending "silent spring" to those who are "as yet unaffected," spreading the warning to educate the public before it is too late. She sees herself as a spokesperson for the birds, but also for those people living in communities that have suffered the effects of indiscriminate pesticide usage, but have not yet had the chance to voice their stories.

What is happening now is in large part a result of the biological unsophistication of past generations. Even a generation ago no one knew that to fill large areas with a single species of tree was to invite disaster. And so whole towns lined their streets and dotted their parks with elms, and today the elms die and so do the birds.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 103

Explanation and Analysis

Carson drives home the notion that a lack of information or education in the public can lead to disastrous consequences, especially given mankind's newfound power to affect the environment. Decisions made in the past have affected the present, since communities chose unwisely to plant a single species of tree - what biologists would call a 'monoculture' - that was therefore intensely vulnerable to disease. The equally hasty and uninformed decision, later in the history of these towns, to defend their poorly-chosen elms with pesticide spraying, has led in turn to the death of the birds - without saving the elms at all.

By presenting these facts in a historical frame, Carson exposes the danger of making a seemingly simple decision to attempt to control nature without understanding its complexity. As intensely interconnected systems developed over millennia, natural ecosystems have much to teach us - and to assume that a simple intervention from mankind will 'fix' them is dangerous and shortsighted. Humanity is responsible for this destruction, because they were arrogant, and misunderstood the consequences of their actions - now they have a chance to change their approach, approaching nature with greater humility.

Who has made the decision that sets in motion these chains of poisonings, this ever-widening wave of death ... Who has placed in one pan of the scales the leaves that might have been eaten by the beetles and in the other the pitiful heaps of many-hued feathers, the lifeless remains of the birds that fell before the unselective bludgeon of insecticidal poisons? Who has decided— who has the right to decide— for the countless legions of people who were not consulted that the supreme value is a world without insects, even though it be also a sterile world ungraced by the curving wing of a bird in flight? The decision is that of the authoritarian temporarily entrusted with power; he has made it during a moment of inattention by millions to whom beauty and the ordered world of nature still have a meaning that is deep and imperative.

Related Characters: Rachel Carson (speaker)

Related Themes:     

Page Number: 127

Explanation and Analysis

Here Carson unleashes a poetic tirade against the system that has made the decision to, in her mind, destroy the beauty and order of nature as it has always existed in favor of some engineered idea that insects must be destroyed at all costs. Again, she asks: who is responsible? She lays blame for this decision on the "authoritarian temporarily entrusted with power," an evil figure, but one who shares the blame with millions of Americans who have ceased to pay attention, allowing this evil to happen while they - the majority, for whom beauty and nature are vitally important - were caught unaware.

Carson's language here is sharp and lyrical, as she describes the "unselective bludgeon" of insecticides, which kill indiscriminately, a manner that seems to her both violent and deeply stupid. She sees this war against the insects, a war that "legions" of Americans never signed up for, as leading inevitably to a cold, empty world "ungraced by the curving wing of a bird in flight," a purposefully poetic and tragic phrase that mourns in advance the future loss of bird life in America.

Chapter 11 Quotes

●● Lulled by the soft sell and the hidden persuader, the average citizen is seldom aware of the deadly materials with which he is surrounding himself: indeed, he may not realize he is using them at all. So thoroughly has the age of poisons become established that anyone may walk into a store and, without questions being asked, buy substances of far greater death-dealing power than the medicinal drug for which he may be required to sign a 'poison book' in the pharmacy next door.

Related Characters: Rachel Carson (speaker)

Related Themes:    

Page Number: 174

Explanation and Analysis

Here, Carson denounces the ease with which poisonous chemicals have infiltrated supermarkets, so that they are now readily available for purchase around the country. She makes reference in this chapter to the Borgias, an Italian family infamous for poisoning their enemies, in order to underline her argument that pesticides should be considered no less dangerous than any poison explicitly designed to kill. Like the Borgias' poisons, these modern poisons are hidden in friendly packages, designed - in Carson's view - to deceive the unsuspecting consumer. The public is insufficiently educated on the topic of chemical poisons, and so believes the empty promises of safety and efficacy printed on pesticides that are used in home gardens, without appreciating the danger of their choice to spray poison in their backyards.

As Carson points out, there is something wrong when the government carefully regulates a less deadly, medicinal drug, while the deadlier poison spray is sold without question to any consumer who wishes to obtain it over the counter. Caution would suggest that the government ought to investigate the potential negative consequences of these sprays more effectively, and over the long term, before it decides how to regulate their use by the public. Moreover, selling pesticides to consumers for garden use reinforces the dangerous philosophy that man should - and can - have complete control over his environment. It is this philosophy that Carson sees as destroying the past and replacing it with a potentially apocalyptic future.

Chapter 12 Quotes

●● Responsible public health officials have pointed out that the biological effects of chemicals are cumulative over long periods of time, and that the hazard to the individual may depend on the sum of the exposures received throughout his lifetime. For these very reasons the danger is easily ignored. It is human nature to shrug off what may seem to us a vague threat of future disaster.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 188-189

Explanation and Analysis

In this quote, Carson highlights a problem in human nature that makes conceiving of the true, long-term dangers of pesticide use so difficult. According to Carson, humans are ill-equipped to consider risks in the long-term, which are much harder to visualize in the present. The problem with pesticides is that their danger lurks almost unseen, and their effects may not be visible until twenty years or more after an initial instance of exposure. Chemicals may accumulate, adding up in small doses over many years until they reach a harmful level in the body, or in the environment. On the other hand, one instance of extreme exposure might have a cancer-causing effect that is not unleashed until years after the incident. This makes it difficult to pin down who is responsible for these health problems, and to what degree any of us are at risk - and this difficulty, in turn, makes it easier for people to downplay the risks, since there may be no obvious effects in the immediate present.

Pesticide use was a relatively recent development when Carson was writing, so no one could know the potential health effects that might crop up fifty years later, or in the next generation. For this reason, because the danger was unknown, Carson argued that precaution was the only morally acceptable way forward until more research could be conducted.

Chapter 13 Quotes

●● There is no reason to suppose these disastrous events are confined to birds. ATP is the universal currency of energy, and the metabolic cycles that produce it turn to the same purpose in birds and bacteria, in men and mice.

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 207

Explanation and Analysis

Carson makes clear a vital component of her argument, linking the damage that pesticides have wreaked among birds and beasts to the potential health effects to humans. She aims to show that, because ATP, a common molecule that provides energy to cells in all sorts of living beings, can be disrupted by pesticides, every type of living thing is vulnerable to their use. Once again, Carson wants to drive home the sense that humans are equally at risk when spraying chemicals - they cannot avoid responsibility for their actions, and nor can they avoid their potentially harmful health consequences. We may not know for certain what exactly these negative consequences will be, but precaution ought to influence us to err on the side of safety, choosing to ban pesticides or limit their use before we find out just how dangerous they could be.

The fact, underlined again here, that all life on earth is interconnected, is a key component of Carson's argument. She uses alliteration to augment the science of molecular energy, linking "birds" to "bacteria" and "mice" to "men" in a way that effectively conveys the fact that all living things, everywhere, are at risk as a result of pesticide use.

☛ But can we afford to ignore the fact that we are now filling the environment with chemicals that have the power to strike directly at the chromosomes, affecting them in the precise ways that could cause such conditions? Is this not too high a price to pay for a sproutless potato or a mosquitoless patio?

Related Characters: Rachel Carson (speaker)

Related Themes:   

Page Number: 216

Explanation and Analysis

Carson again makes her case that caution should govern our actions regarding pesticide use, since the potential risk of making the wrong choice is too high - even if we don't know for sure whether the risk will come to pass. This is our responsibility, argues Carson, since we know that these chemicals can target chromosomes, the basic building block of genetic expression, and could therefore cause an increase in genetic disease. She makes the severity of this

risk clear, and then mocks the relative insignificance of the reasons for continuing to use pesticides - that is, to maintain a "mosquitoless patio" or grow a "sproutless potato," small and silly-seeming luxuries that are, in Carson's view, a symptom of mankind's growing need to control every aspect of his world, in a way that is arrogant, childish, and dangerously short-sighted.

Chapter 14 Quotes

☛ The task is by no means a hopeless one. In one important respect the outlook is more encouraging than the situation regarding infectious disease at the turn of the century. The world was then full of disease germs, as today it is full of carcinogens. But man did not put the germs into the environment and his role in spreading them was involuntary. In contrast, man has put the vast majority of carcinogens into the environment, and he can, if he wishes, eliminate many of them.

Related Characters: Rachel Carson (speaker)

Related Themes:    

Page Number: 242

Explanation and Analysis

Carson now offers a more hopeful view of the future than the one she has been warning against for most of her book. In this chapter, which deals with carcinogens, or cancer-causing agents, Carson has outlined the many dangers that man has put into his environment, poisons that are already harming the health of many populations and whose effects could continue to worsen with time. However, Carson now tells us, the power of man to change his environment in this new era can also be used for good. She uses the example of the near-eradication of many infectious diseases that caused widespread death a century ago to show that technology is in fact capable of reducing pain and suffering in the world. Moreover, although she scolds man for having recreated a situation where such pain and suffering can return - since chemical pesticides seem to be causing an increase in cancer rates - she remains somewhat optimistic. Because we caused the problem this time around, by putting these chemicals in the environment, we can also undo our mistakes by reversing our stance on pesticides.

Chapter 15 Quotes

☛☛ By their very nature chemical controls are self-defeating, for they have been devised and applied without taking into account the complex biological systems against which they have been blindly hurled.

Related Characters: Rachel Carson (speaker)

Related Themes: 

Page Number: 246

Explanation and Analysis

This quote makes clear what is, if not the strongest angle of Carson's argument against pesticides, certainly the most frustrating: they don't even work as they claim to! The supposed efficiency and effectiveness of pesticides for destroying the 'threat' of insects is in large part unproven, and, if anything, Carson shows that they are often both costly and ineffective, leading to greater resistance in insect populations and destruction of the very crops they were meant to protect. This lack of effect drives home the fact that man's presumption that he can control every aspect of his environment by intervening with simple fixes is arrogant and immature. Ecosystems are much more complex than these agricultural engineers could have foreseen, operating in a series of interconnecting and interdependent webs, such that the engineers' drastic chemical methods not only carry risks for every member of the environment, but also fail to perform the job for which they were intended.

Chapter 16 Quotes

☛☛ If Darwin were alive today the insect world would delight and astound him with its impressive verification of his theories of the survival of the fittest. Under the stress of intensive chemical spraying the weaker members of the insect populations are being weeded out. Now, in many areas and among many species only the strong and fit remain to defy our efforts to control them.

Related Characters: Rachel Carson (speaker), Charles Darwin

Related Themes:  

Page Number: 263

Explanation and Analysis

Taking on a tone resembling that of a scolding teacher, Carson simultaneously praises Darwin for his foresight in

developing the theory of natural selection, and forecasts the disastrous consequences of the adaptive ability of insects for human society. As she has shown elsewhere, killing off insects with pesticides only serves to encourage the development of resistance to the chemicals used in widespread sprayings, leading to ever stronger and more resistant insect populations poised to adversely affect crops and human health.

This development of resistance makes sense according to Darwin's theory that the fittest members of a species will survive catastrophe or environmental pressure, passing on their traits to the next generation to improve the species. This means that, ironically, the more intensive the spraying becomes, the stronger the insects themselves become. Carson argues that this is not only an ineffective strategy, but a dangerous one, since it leads to the development of increasingly deadly chemicals and increasingly hardy insect populations at the same time.

Chapter 17 Quotes

☛☛ We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road— the one 'less traveled by'— offers our last, our only chance to reach a destination that assures the preservation of our earth.

Related Characters: Rachel Carson (speaker), Robert Frost

Related Themes:    

Page Number: 277

Explanation and Analysis

Carson makes reference to Robert Frost's famous poem, "The Road Not Taken," to present her vision of the choice that faces the American public: continue the widespread and accelerating use of deadly chemical pesticides as a method of insect control, or ban them as a precaution against a dark future, turning instead to more natural methods of control. By invoking Frost's poem, a famous depiction of idyllic American nature imbued with a large measure of nostalgia for many readers, Carson suggests that the choice represents a battle for the future of America's relationship to nature.

The manner in which Carson describes the first choice - to continue using pesticides - echoes her rhetoric regarding

man's ambitious new technologies for controlling nature throughout the book. She sees these fast-moving technologies as foolish, since they ignore the wisdom accumulated by nature over time, assuming that man knows best how to govern his environment. The image of the "superhighway" makes this dangerous speed clear, with the implication that a fatal crash lies at the end of this path. The path she suggests - the one "less traveled by," which is the one that Frost takes in his poem (a choice that, in the poem, makes "all the difference"), goes against the intense forward inertia of modern progress, suggesting that we ought to slow down and take precautions rather than barrel ahead without considering the consequences.

●● The "control of nature" is a phrase conceived in arrogance, born of the Neanderthal age of biology and philosophy, when it was supposed that nature exists for the convenience of man. The concepts and practices of applied entomology for the most part date from that Stone Age of science. It is our alarming misfortune that so primitive a science has armed itself with the most modern and terrible weapons, and that in turning them against the insects it has also turned them against the earth.

Related Characters: Rachel Carson (speaker)

Related Themes:     

Page Number: 297

Explanation and Analysis

Carson finalizes her argument to the American public, declaring that pesticides are a stupid, dangerous method of asserting the illusion of "control" over nature. Carson suggests that we must reconsider our philosophical relationship to nature, recognizing that the rest of the world does not exist merely to serve man's needs - as the use of pesticides, which destroy so much for the benefit of so few, seems to assume. The problem is a drastically important one now because, as Carson has shown, mankind now has acquired the unprecedented power to affect his environment in massively destructive ways.

Carson makes a clear link to a major conversation of her era, concerning the rise of nuclear weapons and humanity's potential for destroying itself. By describing pesticides as "terrible weapons" that will be turned "against the earth," Carson is calling out to the public - newly educated as they are by the carefully presented facts of her book - to defend the natural world against the foolish actions of those who have opted for the illusion of control over nature, a force that they never fully understood.



SUMMARY AND ANALYSIS

The color-coded icons under each analysis entry make it easy to track where the themes occur most prominently throughout the work. Each icon corresponds to one of the themes explained in the Themes section of this LitChart.

CHAPTER 1: A FABLE FOR TOMORROW

Carson describes an idyllic American town, whose fields and orchards are bursting with beautiful plant and animal life: abundant birds and fish, wildflowers, and vividly colored oaks, maples, and birch. Since the time of its first settlers, this town's natural life has drawn admiration from travelers and delighted locals.

Suddenly, a 'strange blight' strikes the area, leaving a swathe of sickness and death in its wake. Inexplicable illnesses, among both adults and children, puzzle the town's doctors. An eerie **silence** reigns, as birds are found everywhere dead or dying, trembling violently.

Farm animals fail to reproduce successfully, or their young survive only a few days. Apple trees bloom, but without bees to pollinate them there will be no fruit. The lush roadside vegetation withers, and streams are emptied and lifeless, so that no anglers come to visit.

In patches leftover on rooftops lies the culprit; a fine white powder. Carson warns that the people of this imaginary town are themselves responsible for its destruction. "A grim specter", she writes, has crept upon us to **silence** the voices of spring, and her book will attempt to unmask it.

To begin her book, Carson's elaborate description of this beautiful setting – which is deliberately unidentified, so that its appeal becomes universal – creates a nostalgic portrait of life lived in harmony with the natural world.



This blight has the quality of a fairy-tale villain, slowly poisoning the perfect natural setting of the town. Its silence becomes a symbol of the dark future without nature that Carson argues pesticides will create.



Here, Carson demonstrates the links that bind each part of the town and its environment, and shows that the consequences when one part is affected quickly spread throughout the community. These non-specific images will be replaced with real-life examples in the coming chapters.



This serves as the 'moral' of the fable that opens the book. The fairy-tale villain is none other than humans ourselves, or at least the poisons that we—humans—have created. Carson is urging us to take responsibility for becoming educated about the dangers of the pesticides we make and use.



CHAPTER 2: THE OBLIGATION TO ENDURE

The history of life on earth could be thought of as a record of living things interacting with their surroundings; for most of history, this has mostly meant that life is molded over time by the environment it inhabits. But very recently humans have become capable of altering the environment in significant ways.

This is a significant point; Carson believes we have entered a new era in the world's history, in which man has the power to change his environment on an unprecedented scale. Life has always been an interconnected web of mutual influence, but now humans are in a position to affect that web in new and profound ways.



Those alterations have been of an increasingly dangerous nature, and mostly involve widespread contaminations of the natural world that spur “a chain of poisoning and death” as poison is passed between living organisms. It passes through underground streams, and can be changed mysteriously by exposure to sunlight and air, so that its ultimate effects on those who drink from “once-pure wells” remain unknown.

Here is Carson’s basic thesis about the dangers of pesticides. She urges caution because alarmingly little is known about their effects, and because what we do know – that they move through and are changed by the environment in unpredictable ways, and that they cause a harmful ripple effect in the interconnected web of life – means that they could pose a dire threat to humans.



One of the scariest aspects of this pollution is the speed with which it has taken hold. Although there are naturally occurring dangers from small amounts of radiation or chemical exposure, life has created a careful and resilient balance over the course of millennia in defense against them. The “heedless pace of man” in developing new poisons means that natural selection is not given the chance to develop these defenses. Many of the changes Carson describes have taken place over just the previous twenty-five years – which is a mere moment in geological time.

Rather than following the example of nature, Carson sees man as sprinting ahead at an unsustainable pace – her critics would cite this as an example of her ‘anti-development’ tendencies. In fact, Carson encourages development but urges caution, and a respect for the methods of nature, which have been ‘developed’ over millennia. The fragility of this age-old balance in the face of man’s new power is also frightening.



This “heedless pace” is truly astounding: 500 new synthetic chemicals are introduced in the U.S. alone each year. This includes those used in “man’s war against nature,” the insecticides designed to combat the perceived pests. Carson refers to these pesticides with her own term, “biocides,” or ‘life-killers,’ making the case that the destruction they cause is by no means limited to the insect world. She argues that this combat against nature creates a useless spiral of violence, destroying many species that were not the initial target of pesticide spraying and spreading chemicals that accumulate dangerously in organic tissues.

The recklessness of chemical development is, for Carson, a sign of humanity’s arrogance in this new, fast-paced age. Instead of living in harmony with nature, humans have chosen to take up arms against it. By calling pesticides “biocides,” Carson makes two points: 1) that these poisons are not just targeted to “pests”—they kill all sorts of living things; 2) that with these biocides we have begun a war against life itself, a war whose effects will be felt by humans in unexpected ways. Because life is an interconnected system, it is impossible to target only the ‘pests’ that humanity wishes to destroy.



We are told by their supporters that these pesticides are necessary for farm production, but in fact there is a problem of food *overproduction*: each year the U.S. pays one billion dollars to subsidize the surplus-food storage program. This disconnect between reality and the language used by politicians or people in the industry is typical of the logic of urgency that many lawmakers use to justify insecticide use whenever there is a pest problem that they view as a ‘crisis.’

This statistic on overproduction is part of Carson’s goal for the book: to educate the public, speaking directly to citizens and providing a different perspective from the one commonly taken by politicians and proponents of the chemical industry, which tends to exaggerate the pest problem, which in turn helps them sell more pesticides.



There may be an insect problem, but our notion of it is out of proportion with reality. Insects do in fact trouble humans if they carry disease in crowded areas or interfere with the food supply, but chemical methods of control have often backfired, causing wide harm and failing to eradicate the pests in question.

Carson admits that pests can pose real problems, but here she speaks to another frustration – that other, less destructive methods of control are not considered, although chemical methods are often both dangerous and ineffective.



Moreover, the agricultural problem is in fact a *product* of modern, intensified methods of production – agriculture that is “engineered” instead of operating according to natural principles - that leave crops vulnerable to attack. One species of pest can flourish explosively when farmers plant a field composed exclusively of a single crop (as opposed to the time honored tradition of planting a field with multiple crops), and that single crop is then vulnerable to any attack or disease because of its lack of diversity.

Non-native insect species introduced to new regions by accident pose another issue in insect control. Most often, these insects hitchhiked to the new area on imported plant species. When they arrive, they enter an ecosystem without the predators or parasites that normally keep them in check, and their populations can balloon rapidly. Quarantine and pesticides campaigns against such pests are expensive and ineffective. Invasive species are better dealt with by other means.

Paul Shepard, an American environmentalist thinker, writes of life “with only its head out of the water,” barely clutching on to survival conditions. Although no one would seem to desire this sort of life, it is pressed upon us by the “ruthless power” of regulators in state and federal agencies who are enamored by pesticides. It is almost unbelievable that they should have the right to pollute on behalf of the whole population, which has no say in the matter.

In addition to the problem of regulation of pesticides, there is a lack of research into the negative consequences of these materials. Industry officials dominate discussion of the topic, silencing protests that urge caution and issuing false assurances of safety. The public must actively demand to know the facts about pesticide use before continuing down its current path of action.

CHAPTER 3: ELIXIRS OF DEATH

For the first time in history, every human being is exposed to dangerous chemicals from the moment they are conceived. These substances have been found everywhere: in organisms in remote lakes, earthworms burrowing in the soil, and humans all over the world. Their production began during WWII and has grown rapidly ever since. New pesticides are incredibly potent, Carson warns, with the ability to affect important processes in the body. If we are to live so closely with them then we had better understand them better.

This explanation for the fragility of crops in the current agricultural world is in line with Carson’s consistent argument that nature is a complex ecological system, developed through checks and balances over thousands and millions of years, which should not be disturbed without proper precautions. It is arrogant of man to attempt to ‘engineer,’ over the course of a few decades, a better system than nature’s own.



By explaining the ways that invasive species can become entrenched in a new environment, Carson is again demonstrating the important relations between species that exist in nature. She wants to educate her readers about the realities of the pest issue, while introducing an understanding that pesticides only worsen a problem that could be solved by natural means, which she will discuss in later chapters.



Here, Carson presses a few of her key themes. First, she offers a vision of the present and future that is cramped, desperate, and precarious – an exercise in survival – in contrast to a past lived fully at peace with nature. On behalf of the concerned public, she then questions the regulators responsible for creating these conditions, and urges caution and a return to the past.



Carson’s insistence on the value of research before undertaking massive aerial pesticide spraying is echoed in modern environmentalism’s support for the “precautionary principle,” according to which if the potential dangers of a new invention are unknown, it should not be put into the world until more testing has taken place. Carson places the responsibility for enforcing this principle on the public.



This is a new era of man – even though these synthetic chemicals have only been in existence for two decades, by using them so extensively we have already changed our environment in subtle but all-pervasive ways, so that all of us have been exposed to these chemicals. It is the public’s responsibility to become educated about the chemicals that have invaded its present, and will continue to shape its future.



Arsenic is chief among the older, inorganic pesticides. It is naturally occurring in small amounts, and highly toxic – a favorite poison since the time of the Borgias, an infamous dynasty from the Italian Renaissance. Arsenic contamination kills many species and has carcinogenic (cancer-causing) effects in humans. Nevertheless, it is sprayed with “supreme carelessness” according to Dr. W.C. Hueper, a leading expert on environmental cancers.

By recalling the use of arsenic by the Borgia family, Carson means to emphasize the chemicals infamous past as a deadly poison and in doing so question how modern people could possibly use it as a pesticide that is sprayed so carelessly. She also introduces what will become a major topic later in the book –the idea that pesticides can cause cancer, a disease that many of her readers will have some experience with.



Modern insecticides are deadlier still. There are the chlorinated hydrocarbons, including DDT, and the organic phosphorus insecticides, including malathion and parathion. They are organic, built from carbon atoms within methane molecules that have been altered in small but significant ways. Normally, for example, methane is composed of one carbon atom and four hydrogen atoms, but scientists have discovered that substituting chlorine for one of the hydrogen atoms creates methyl chloride.

Whereas arsenic occurs naturally in small doses, these new pesticides are a creation of man – and man has outdone himself, manufacturing a range of deadly poisons. On the one hand, Carson seems to celebrate the ingenuity of modern science, but she also underlines the unpredictable nature of the changes created by small alterations in the molecular make-up of these chemicals.



DDT is often thought of as harmless, because it was used in powder form to combat lice during WWII - however, in liquid form it is much more toxic, and can accumulate in the body over time. Scientists disagree about what level of accumulation is tolerable, but studies have shown that a majority of people carry unsafe levels stored in their bodies’ fat cells and vital organs, where it can build up over time. DDT in fat cells is then released over time with exertion, leading to chronic poisoning.

DDT would become a focus of Carson’s followers, who eventually succeeded in getting it banned in 1972. Carson’s focus on the issue of accumulation—in which repeated exposures at a ‘safe’ level build up within the body to produce unsafe levels of exposure – highlights how little we know about the behavior of the chemicals we are using in the real world. Her attitude of cautious skepticism is in line with the precautionary principle.



The chemical is transmitted through the food chain, and even from mother to child. If a crop of alfalfa is dusted with DDT, and then chickens are fed with infected alfalfa, their eggs have been shown to contain DDT afterwards. The same mechanism of transference has been found to function in human mothers who transmit DDT through the placenta during pregnancy or in their breast milk.

The idea that DDT and other toxins can be passed across the ‘germ line,’ which is to say, from generation to generation, raises a new set of moral questions. We are not only poisoning ourselves, but also transferring mutations and toxins to the next generation, who bear no responsibility for their creation.



Chlordane, Heptachlor, Dieldrin, and Aldrin are other pesticides in the same family (chlorinated hydrocarbons) as DDT, and each is widely used in aerial spraying of crops. Each also builds up through food chains and over time, and is many times more toxic than DDT, with evidence of seizures, sterility and death resulting from exposure. In one instance, a group of pesticide sprayers working against malarial mosquitoes substituted Dieldrin for their usual DDT and exposure to the chemical led to seizures and death among the sprayers themselves.

By listing the types of pesticide, Carson underlines their variety and how widespread they are. This anecdote of the poisoned sprayers is particularly evocative; the workers, in their attempt to use the sprays against the mosquitoes, wind up injuring themselves. This mirrors what Carson believes to be happening on a larger scale: humans, in their war against the pests, are poisoning themselves – perhaps fatally.



Endrin is the most toxic pesticide of all; for birds, it is 300 times more toxic than DDT. Carson recounts a series of terrifying anecdotes of its use, including the story of a child who went into a permanent vegetative state and a small family dog that died within hours after they had played on a floor that had been sprayed against insects.

Carson uses the story of the small dog and infant to make the effects of these toxic pesticides tragically real to the reader by demonstrating their ability to harm the most innocent and helpless members of society. Who is responsible? The horrified parents, or the companies who sold the spray?



Organic phosphates, the second group of pesticides, have their origins in German labs, where they were discovered by a chemist named Gerhard Schrader and then weaponized during WWII as nerve gas. They attack the nervous system, destroying enzymes that are vital to the proper transmission of impulses from nerve to nerve. Without this enzyme, an excess of transmitters builds up, causing convulsions and death.

The fact that the development of many pesticides came as a result of weapons research during World War II further supports Carson's idea of a 'war against nature,' and in reminding her readers of this fact Carson also underlines the strangeness of this former weapon being used as though it were completely harmless, highlighting its dangerous effects on the nervous system.



An enzyme in the body naturally protects against the effects of organic phosphates, but repeated exposure in small doses can wear this defensive measure away. Instances of parathion poisoning are increasing in the U.S., and although they are less persistent than other pesticides, organic phosphates' effects can be extreme.

This point reinforces the idea that pesticides cannot be thought of in terms of individual exposures. The natural defenses of the body are part of that ecological balance developed over millennia that Carson has described, and their disruption has unexpected consequences.



Malathion, another organic phosphate widely used in home gardening, demonstrates another important principle about synthetic chemicals: in combination they can react together in unexpected ways to inhibit natural defenses and become much deadlier. Further, these combinations can happen inside the body from separate exposures that happen over time, since chemicals build up in the body's tissues.

Another warning that, although individual chemicals can be tested in isolation, the ways that they will interact in the environment – or even within the body itself – are much more difficult to predict. This basic unpredictability is a major reason to follow the precautionary principle.



Systemic insecticides are used to make plants poisonous to the pests that eat them. Carson compares them to the mythical dress that Medea, of ancient Greek mythology, gave to a rival, which when worn caused a violent death. These 'built-in' insecticides make all of the tissues of a plant or animal toxic to the insects that prey on them, but this toxicity can also be transferred in uncontrollable ways to living beings other than the targeted pests.

As with her earlier reference to the Borgias, when Carson here compares systemic insecticides to Medea's deadly dress she is drawing upon a common cultural well of knowledge about poisons. By associating pesticides with this tradition she is challenging their perception as simple, harmless, helpful sprays.



Herbicides, poisons that target plants, are also toxic, and the myth that they are no threat to animal life is false. Many have been banned in England and Australia, although no such restrictions exist in the United States. Dinitro, penta, and amitrol are examples of herbicides with hidden, cancer-causing effects that can sometimes be transferred down the germ line, meaning that their effects carry on from one generation to another. If we are so worried about nuclear radiation, asks Carson, how can we be indifferent to the synthetic chemicals in our environment?

Widening the scope of her argument from pesticides to herbicides, Carson continues this challenge. By comparing the policies of other major countries to the United States', she legitimates the concern about cancer caused by such sprays. Finally, by comparing the effects of synthetic chemicals to those of nuclear radiation, she takes advantage of an issue – nuclear radiation – that at the time had earned a lot of public attention and concern in order to create urgency.



CHAPTER 4: SURFACE WATERS AND UNDERGROUND SEAS

Water has become the most precious natural resource in this modern age, but humanity is indifferent to and unaware of the dangers facing this environmental system. There are many kinds of pollutants affecting the water supply, but it is the mixture of these chemicals that is particularly threatening, since the interactions between these chemicals are poorly understood. Rolf Eliassen, a professor at M.I.T. testified to this effect at a congressional hearing on water purity, warning those assembled that we do not know what is in our water.

This is the first of the chapters in which Carson tackles individual parts of the environment to show their vulnerability to pesticides. A main theme, again, is just how little is known about the potentially dangerous effects of these chemicals on the precious water system. Since water is a fundamental part of human life, as well, the focus here is on the unknown substances in drinking water that humans consume.



Insecticides are being applied directly to water systems, or indirectly via aerial spraying that then becomes mixed in with agricultural runoff water, making these systems toxic to fish. Further, discoveries of DDT traces in fish *upstream* of contamination or spraying sites suggest that once these chemicals get into the groundwater that the groundwater transfers the chemicals all throughout the system. This means that all water is threatened by contamination anywhere.

The water system is a particularly good example of the ways in which nature is an interconnected system; it is impossible to treat water 'selectively,' since any contamination spreads throughout the environment. Most often, water is not sprayed purposefully – but chemicals find a way to contaminate it nonetheless, beyond the control of humans.



Chemicals from agricultural runoff have been found to contaminate drinking water even after the runoff has passed through water purification plants. Chemists have little understanding of what chemical combinations might be reaching the public, how to test for them, or what their effects might be.

This situation, in which dangers are unknown, massive, and insufficiently researched, requires that the public exercise caution and slow down the rapid spread of chemicals according to the precautionary principle.



Carson recounts the story of a farming district in Colorado contaminated by chemicals that had leached into the water table from the Rocky Mountain Arsenal—a factory that produces pesticides—located several miles away. Over seven or eight years, these chemicals had traveled through the groundwater to pollute local wells. Most alarmingly, wells tested positive for a synthetic chemical called 2,4-D, a weed killer that had apparently formed spontaneously in when certain chemicals combined, independent of human oversight.

Here is a concrete example of the sort of environmental changes undergone by chemicals that Carson has been hinting at – the unaided formation of 2,4-D is a sign that poisonous substances can result from these interactions. The time since contamination – eight years – demonstrates that the effects of spillage or leaching can be long term, making them very difficult to detect.



In another example, at key wildlife refuges in Oregon and Northern California, agricultural runoff of DDD and DDE caused mass poisonings of migratory birds within ‘protected’ zones. The poisons were passed up the food chain from plankton to waterfowl, as fish that ate infected plankton accumulated a larger dose, and waterfowl that ate infected fish concentrated the poison within their own bodies further still. This process in which poisonous chemicals become more focused as they move up the food chain, is known as *bioaccumulation* or *biomagnification*, and is particularly dangerous because of its impact on humans, who are often at the top of the food chain.

In Clear Lake, California, fishermen chose to dose ‘gnat-infested’ waters with DDD, even though the gnats were not especially harmful. Despite ‘careful planning’, the operation had to be repeated, and the following winter revealed that other species had been affected. The western grebe, a bird of “spectacular appearance,” died out completely in the area, having eaten fish that had in turn eaten infected gnats and plankton, again accumulating increasingly concentrated doses of the chemical. Because the chemicals had passed from the lake into the tissues of its inhabitants, initial tests of the water had suggested that it was safe.

Carson questions the wisdom of using substances with such strong biological effects that can impact the drinking supply. Dr. Hueper has warned that cancer hazards in public drinking water are increasing, and there is evidence to support his claim. The complex, interconnected nature of the water system, especially, supports Carson’s claim that “in nature nothing exists alone.”

This example illustrates the ways that nature’s interconnected systems can spread the effects of a poison that is meant to target only a single species of pest to other parts of the natural community – including those parts that humans have designated as worth protecting. Bioaccumulation, explained here, is a key part of this ripple effect, transferring poisons from insects to birds, larger mammals, and humans themselves.

Carson emphasizes that the gnat was not a dangerous pest – merely an annoyance. When the fishermen decided (recklessly, or arrogantly, as Carson would see it), to exert their control over the natural world, their efforts backfired, as bioaccumulation led to the poisoning of the western grebe. The fact that this contamination was initially undetectable should inspire caution in a reader, who may have been assured of the harmlessness of pesticides in the past.



Carson concludes the chapter by returning to the dangers posed to humans by contaminated drinking water, with the new awareness of the interconnected nature of the water system and its inhabitants to support her suggestion that current practices are foolish.



CHAPTER 5: REALMS OF THE SOIL

Soil supports life – its nutrients fuel plants, and by extension, most of the world’s animal life as well – but it also *formed* by life. It is full of living things, including vast quantities of microbes, bacteria, and fungi that interact in complex cycles of soil development, decomposition, and fertilization. Carson argues that scientists have not fully considered the negative effects of pesticides on this delicately balanced ecosystem – not enough research has been done, and the potential for danger is large.

Soil is the second environmental system Carson will address, and the initial diagnosis is similar: soil is formed by a web of complex interactions between various microorganisms, and its role in supporting plants is vital. Because the system of soil formation is so complex, and poorly understood, precaution should be used when considering applying pesticides.



Microscopic soil inhabitants convert decaying matter into nutrients for plants, which are also reliant on the nitrogen and carbon dioxide generated by bacteria. Of the larger soil-dwellers, the earthworm is perhaps most important. It performs a vital role as soil-mixer, helping to aerate and transport vast amounts of soil each year. But, in fact, each member of the soil “community” has a highly specific task that is related to and enriches the others. So, asks Carson, how can we expect that a nonspecific fungicide or broad-spectrum insecticide—poisons that are not targeted to kill a single pest but in fact will kill all sorts of insects and bacteria—will not destroy the good along with the ‘pests?’

This problem has been largely ignored, by control agencies and scientists alike. Some pesticides have been shown to disrupt nitrification, an important process that produces nitrogen in the soil. Pesticides can also disrupt natural predator-prey checks and balances and lead to the flourishing or destruction of different organisms – sometimes the very pests that insecticides were meant to control. When larger insects, like praying mantises, for example, are destroyed, the insects that were their natural prey can reproduce unchecked. Most alarmingly, these chemicals have been shown to persist in the soil for years, accumulating over multiple single applications of ‘safe’ dosages to eventually reach dangerously high levels.

Arsenic in tobacco fields provides one example. Even though arsenic has been replaced by synthetic insecticides in the production of tobacco, the arsenic content of American-grown tobacco increased 300-600% from 1932-52. This is because residues from *previous* episodes of arsenic spraying in the soil are breaking down into a form that dissolves into water and is then absorbed into the plants.

This introduces the issue of plants absorbing pesticides into their tissue through the soil. Hop growers in Washington and Idaho were advised to use a pesticide called heptachlor to treat the soil against a pest called the strawberry root weevil, but vines planted after treatment withered and died. Even after the area had been replanted, the poison persisted in the soil and was absorbed by plants. Different plant species also absorb these poisons in the soil at different rates, although research in this area is minimal. Clearly, little is known, and the danger is potentially enormous.

This is the basic problem of so called ‘blanket spraying,’ in which pesticides are applied to an entire area with the assumption that they will only affect the targeted pest – in reality, their effects are quickly distributed around the environment and its inhabitants, whose interconnected nature means that no one part can be affected without disrupting the entire system. This is particularly dangerous when the ‘system’ in question is so vital to the health of the whole world.



Although the soil may not be a glamorous and well-researched topic, its function is fundamental to plant growth. Because it is difficult to know, fully, the ways that an ecological system functions, injecting pesticides into the process can have unexpected results, even results that favor the targeted pest. This fact supports the idea that man is out of his element in attempting to exert an artificial control over nature. The effects of accumulation in the soil also demonstrate this seeming inability of man to think ahead before poisoning his environment.



This is a prime example of the long-term effects of pesticide use. Although they are marketed as a quick, harmless, one-time fix, Carson has shown that in fact they persist in the environment, often require multiple applications, and can affect health over decades of accumulation. Our environments have already been changed, in ways that no one could have predicted.



This anecdote is significant because it shows farmers – or in this case, hop growers – who are often seen as the biggest supporters of pesticide use, being negatively affected by unpredictable effects of these chemicals, even after having followed instructions from the authorities. We may think we have mastered these substances, suggests Carson, but in fact their function is beyond our understanding – caution is required.



CHAPTER 6: EARTH'S GREEN MANTLE

Man cannot exist without plants, but we have a narrow view of their usefulness and are quick to label them as undesirable – and attempt to eradicate them – if they serve no immediate, obvious purpose. However, each plant is part of a complex web of life, and the essential relationships between actors in that web should not be disturbed without careful thought. Unfortunately this is not the normal procedure with modern spraying practices.

The attempted eradication of the sagebrush from the West is a perfect case study. The sage is a result of long ages of experimentation by nature, and is perfectly adapted to its unique, harsh environment at the edge of the Rocky Mountains. It lives in concert with other creatures in its environment, like the sage grouse, a bird that, during mating season, loosens the soil beneath and around the sage so that grass can grow.

When farmers decided to clear away the sage with pesticides to create more grazing land, the other organisms that had grown up alongside it, including the sage grouse, the pronghorn antelope, and sheep, for which sagebrush was an important grazing material in its own right, immediately suffered. The grass that the sage had sheltered also disappeared, crippling the farmers' plans. Further, without sage there was nothing for livestock and wild grazers to eat during the harsh winters.

Another case comes from Supreme Court Justice and environmental writer William O. Douglas, who tells the tale of herbicide sprayings in Bridger National Forest in order to try to eliminate the sage. Untargeted spraying for sage also killed the willows, which had been home to the rare and wonderful moose, and disrupted beaver communities. Without the beaver dams, a beautiful trout lake at the end of the stream drained away, and this natural jewel and popular destination was lost.

Carson argues that weed-killers are tempting toys that appeal to those who want the spectacular illusion of power over nature and can believe in a 'cheap' alternative to mowing without considering true costs. One of these costs is in tourist goodwill, after beautiful roadside vegetation has been destroyed by the indiscriminate spraying of intolerant or careless weed sprayers, who view any brush at all as undesirable. In Maine, Connecticut, and Massachusetts there has been public outcry after spraying devastated natural undergrowth.

Here we see the new era of man – in which humanity feels empowered to shape its environment – confronted with the question of responsibility, and with its own limits. Who has the right to decide what in the environment is “undesirable,” particularly when that environment is one that has been carefully calibrated over millennia?



This is another illustration of the interconnected web of species and environment that scientists refer to as ‘ecology.’ It also recalls the radical difference in the speed of man’s development, which is fast and furious, and nature’s, which is slow and careful. When one approaches the other, the fragile natural balance is disrupted.



And here Carson demonstrates that disruption. Carson shows the ways in which violence against the sagebrush ended up harming the entire ecosystem, while the humans behind the plan failed to achieve their goal – in fact, their aims were also actively harmed by the eradication of the sagebrush, which turns out to play a key role for grazing.

Carson’s citation of William O. Douglas gives her claims about the sagebrush new legitimacy from a prominent witness. His account is tinged with the nostalgic tone that Carson often adopts when remembering the past of a place, before pesticides disrupted the balance and led to the destruction of what had been treasured by many.



Here, Carson continues to ridicule the idea that man can control nature without creating negative consequences, villainizing the sprayers of roadside weeds who have taken it upon themselves to destroy a portion of the forest with aesthetic value for many people, in addition to its ecological importance. The public seems united against these ‘sprayers,’ in Carson’s vision, and need only speak up for itself in a unified way.



Carson describes with feeling one stretch of road she knows personally that which has been sprayed, with the exception of a few oases that now serve as painful reminders of the beauty that existed before. Why, she asks, must we consider all of this beauty to be ‘weeds’? She recounts another passage from the writings of Justice Douglas on sage lands, who eloquently defends the right of an old lady to question those who planned to destroy the sagebrush because their spraying would also destroy local wildflowers. We have a right, argue Douglas and Carson, to the aesthetic pleasure of natural beauty.

Carson strays from the strictly scientific here into the realm of morality and sentiment. She evokes the beautiful past, with colorful wildflowers lining the roadside, to contrast it with the dead, brown areas that have replaced it in our present. Engineering nature, argues Carson, removes something beautiful and necessary from the human experience of the world – something which ought to be not only remembered and celebrated, but protected for the future.



Beyond aesthetic considerations, there are practical reasons not to destroy so-called weeds. They provide the habitat for pollinating bees and other essential insect life, as well as animal life. Blanket spraying, in which whole areas are covered with a shower of untargeted pesticides often must be repeated when weeds return. Other methods, like smarter, selective spraying that only attacks unwanted, tall weeds, make use of the natural ability of persistent shrub cover to ward off the growth of taller weeds, and are therefore more effective and less disruptive. If taxpayers understood the inefficiency and danger of blanket spraying they would demand a change.

In her role as defender of the natural world, Carson returns to the practical and lists the ways in which blanket spraying is less effective, more destructive, and ultimately more expensive than targeted spraying. The merits of targeted spraying stem from its understanding of the ecology of roadside vegetation, and Carson believes that the public, when educated, will be smart enough to see that these options are preferable. It is Carson’s explicit goal to provide this education.



Herbicides like 2,4-D also have negative effects on livestock and wildlife that are not well understood. The herbicides accumulate in the soil, and can change a plant’s metabolism so that it produces more sugar and becomes more attractive to livestock – who can then be adversely affected (or killed) by eating the infected plant, which they might normally avoid.

Carson uses the background she has already provided about the ability of insecticides to alter fundamental functions of an ecosystem, extending her argument to the related world of herbicides. The example of the infected plant seems particularly alien and unexpected, underlining how little is known about the unintended consequences of these chemicals



Moreover, the positive effects that certain ‘weeds’ have on the soil are underappreciated – we must remember that soil processes exist within a system in which many players participate. In Holland, marigolds that were planted among dying roses helped to control the spread of harmful nematode worms, a solution that has now been replicated elsewhere. By spraying without considering the many interdependencies at work in ecosystems, humans are changing the nature of wild habitats in unknown and long-lasting ways.

Just because a certain plant is an annoyance to humanity, for whatever reason, does not mean that it serves no beneficial purpose for its neighbors. The anecdote from Holland is a perfect example of the ways that natural controls, like the marigold, can be used in place of herbicides. By increasing the diversity of flower beds, we would be moving away from an engineered, human-controlled state back toward nature.



As proof that blanket spraying is ineffective, Carson considers the case of ragweed. Spraying ragweed does kill it, but the plant is an annual, which means that seeds sprout anew every year. And the new sprouts need clear soil in order to thrive. While blanket spraying kills the ragweed, it also kills everything else, providing exactly the open soil that ragweed requires to grow the next year, which then requires more spraying, etc. A better strategy for controlling ragweed would be to plant stable perennial vegetation, whose year-round presence would limit any open soil and serve to restrict the new growth of ragweed each year while also reinvigorating wild habitats.

Other intelligent, cheap, natural strategies for 'weed' control exist, including the importation of natural predators to control invasive species. Klamath weed, an incredibly fast-spreading invasive species in the American West, was controlled by an imported beetle. In a similar fashion, rampant populations of imported prickly pear in Australia were reigned in by an Argentine moth. These alternatives are far preferable, argues Carson, to the destruction caused by herbicides.

This is a prime example of the ways in which man's quickly developed and poorly researched chemical approach to pest control can backfire when introduced into the complex web of interactions between species in nature. Carson offers a clear alternative that observes the example of nature and imitates its system of checks and balances. This option, rather than further destroying natural habitats, would strengthen them.



In California, as we will see later, natural methods have been adopted with great success that could be replicated elsewhere. These methods take advantage of pre-existing predators, imported from an invasive species' native zone to reintroduce a natural check that had been missing in the environment, naturally controlling the pest population.



CHAPTER 7: NEEDLESS HAVOC

Mankind's brutal legacy of destruction of other species, from the slaughter of the buffalo to the near extermination of the egret, is being repeated in pesticides. It would seem that nothing takes priority over the spray gun. One question is whether to believe the agencies in charge of insect control, who insist that no losses occur outside of the targeted pest, or wildlife biologists and witnesses who assert that destruction from spraying has been catastrophic. Surely, answers Carson, the scientists and locals on the ground are more trustworthy witnesses than chemical manufacturers and government regulators. These local parties have often expressed sadness or anger at the destruction of the wild places and animals they held dear.

The case of the Japanese beetle in the Midwest provides a basis for Carson's arguments against pesticide spraying. In Michigan, in 1959, 27,000 acres of land were dusted with the pesticide aldrin, even though little need was shown for such measures. Despite reasonable control of the invasive beetles in the northeast without excessive spraying, Midwestern pest control agencies have taken a dramatic, pesticide-based approach in light of recent encroachments of the beetle on their states. The highly toxic aldrin was chosen as the least expensive poison, and citizens were told not to worry about any dangers.

As they begin to mourn the loss of the beautiful natural world they inhabit, concerned citizens need to unite in order to prevent another environmental disaster. Currently, not enough voices in power are questioning the dominance of synthetic chemicals as a control for pest populations, despite the evidence of their destructive power. Carson's mission is to gather the evidence from locals and scientists and publish her findings in the form of a popular science book – this one – that can motivate change.



By highlighting the fact that the Japanese beetle had been controlled effectively by non-chemical methods in the Northeast, Carson emphasizes that this destructive insecticide-focused method is not necessary, as some lawmakers claim. Unthinking reliance on the chemical option seems to be the only explanation for choosing one of the most toxic poisons to begin the program, simply because it is least expensive. Who is responsible for this choice?



Despite hundreds of concerned calls from citizens, spraying went ahead as planned. Pellets of the pesticide built up on rooftops, and signs of poisoning came shortly afterward, as cats, birds, and humans showed symptoms related to pesticide exposure. The government categorically denied any wrongdoing. Other Midwestern communities experienced similar effects, and entire bird populations were “virtually wiped out.”

In Sheldon, Illinois, repeated heavy spraying – despite eyewitness reports of its devastating consequences – led to massive losses in wild and domestic animal life. Even so, officials rejected the proposed legal limitations that would have required prior consultation with the U.S. Fish and Wildlife Service before spraying, and the research budget for the project was tiny – \$1100 for two years of study.

As a result of the aerial spraying in Sheldon, which at one point used Dieldrin – a toxin that had been shown to be fifty times more poisonous than DDT – at an intensive rate of three pounds per acre, birds fed on poisoned worms and beetles, and were killed or rendered sterile. Many small mammals in the area suffered similarly tragic fates. Still, spraying continued and more toxic poisons were used. Over eight years, the budget for chemical pest control was over \$375,000, but researchers looking into the impact of the program were only allocated \$6,000.

Frustratingly, efforts to control the Japanese beetles by more natural means had already succeeded in the northeast. Predators and parasites that target the beetle specifically were imported from the Far East and proved very effective, and also revealed the beetle’s vulnerability to ‘milky spore disease’, which could then be spread artificially to control populations. The use of pesticides to control the beetle in the Midwest was therefore justified *only* because of a sense of crisis that was fundamentally false. In reality, the problem had been controlled with better strategies elsewhere, and only the modern trend toward immediate results supported pesticides over these methods. Moreover, the chemical solution is inevitably temporary, allowing the industry to win contracts for spraying year after year.

This war against nature being waged by chemical manufacturers begs the question: how long can we destroy the world around us without “losing the right to be called civilized” on the one hand and eventually destroying ourselves on the other? In the often very painful animal deaths described by local witnesses, does not some part of our dignity as human beings also die?

Carson’s description of the aftermath of aerial spraying echoes the fable of a silent spring that she presented in the first chapter of the book, down to the white residues that accumulate on the roofs of the community and the symptoms of local wildlife and pets. Here she is showing that the apocalyptic “future” she envisioned is, in fact, our present.



The problem of limited funding for research is one that Carson will continue to raise. This is what she means when she describes man’s pace as “heedless.” All efforts to limit the power of the chemical industry are rejected, and so caution is thrown to the wind in spite of accounts that should raise serious questions.



Here again the relatively tiny budget for research is placed in contrast with the seemingly widespread destruction caused by pesticide spraying, much of which is a result of bioaccumulation that passes toxins up the food chain, as discussed in previous chapters. This is further evidence of the interconnectedness of nature and the need for caution, rather than the arrogance of an attempt for total control through artificial methods.



Carson reinforces her argument that the only reason behind selecting pesticides over more effective, less expensive, and less destructive natural controls is some sort of financial interest. The groups that benefit from the production of synthetic chemicals also benefit from the false sense of crisis that justifies their use, and have no incentive to consider other, more natural means, even when they have been proven effective, as in the case of ‘milky spore disease’ with the Japanese beetle. The public needs to push back against the dominance of this industry.



Returning to moral issues, Carson challenges the public very openly. Now that she has provided the information, and ignorance is no longer an excuse, we are all guilty of the violence being perpetrated against the natural world – unless we do something to stop it. What future do we want for ourselves, and our planet?



CHAPTER 8: AND NO BIRDS SING

Here, Carson returns to the symbol of **silence**, and to the threat of chemical “biocides” against birds, whose absence is often most acutely felt by locals. She cites local accounts from all over the country of dwindling bird populations after spraying against elm disease or fire ants, giving voice to residents who mourn the loss of the color and songs of birds.

As a symbol of this destruction, she chooses the robin, a bird whose return normally heralds the end of winter. Its springtime arrival is no longer guaranteed, however, as widespread spraying against the beetle flies that carry a fungus that causes Dutch elm disease in elm trees has decimated robin populations.

John Mehner, a graduate student at MSU, demonstrated the causal link between spraying for Dutch elm disease and robin population drops after studying robins on the MSU campus as part of his dissertation. Sterility and death resulted from spraying, after robins ate earthworms that had ingested the poison when sprayed leaves fell in the autumn and decayed into a mulch – another example of bioaccumulation, in which poisons grow more concentrated as they move up the food chain. After spraying, Mehner found that robin populations had dropped from 370 to a mere two dozen adult birds, and *no fledglings at all were found*.

Similar studies showed that 86-88% of robins had died, while the birds’ reproductive organs were found to contain dangerous levels of DDT. This wave of deaths reached other species as well, affecting a whole chain of animals for which earthworms are a major element of their diet. Carson includes an extensive list of these birds and their qualities, those whose “wings are touched with flame” or who are “ruby-crowned.” She notes also that with the death of their natural predators—birds—insects begin to thrive, often reversing the desired effects of spraying so that the whole exercise becomes a futile one.

In the book, birds function as an emblem of the loss of wildlife, symbols of nostalgia and an idyllic past that could serve to unite the public in their defense. Carson wants to give the public a voice by citing accounts from locals, reinforcing the idea that many people are concerned with the future of wild life in America.



The robin is chosen partly because it is well-known and loved – Carson hopes to inspire action on its behalf, and on behalf of the previous time in which its return was as regular as the changing of the seasons. This regularity is threatened in the new world created by man.



The careful work of biologists across the country and around the world is a key part of Carson’s book, and she celebrates their work by giving it a wider platform. The story of the elms is similar to what we have seen before; bioaccumulation allows toxins to pass up the food chain. The importance of sterility in causing population decline is re-emphasized here. The rapidity of decline is particularly troubling, since this is only one window into a problem that spans the country.



The language Carson uses to describe these suffering or disappearing species of birds celebrates their beauty in lyrical phrases, remembering a glorious past and envisioning a future without these beauties. Further, the sacrifice of these many-colored creatures is purposeless: because the pesticides end up killing the birds, which are the natural predators of the insects that were the intended target of the spraying, the insects end up thriving while the birds are destroyed! Insects can find a new foothold in an empty environment far more quickly than birds can.



Owen J. Gromme, Curator of Birds at the Milwaukee Public Museum, wrote to the *Milwaukee Journal*, reporting that accounts of dead birds were growing steadily with the pace of spraying. Locals lament that, in an attempt to save the elm, authorities have chosen a course of action that seems to destroy bird life. Surely this is a foolish bargain to strike, they suggest. Statistical evidence from Connecticut shows that spraying is not even effective at saving the elm, and New York State has had much more success with selective removal of diseased wood, or the planting of hybrid, disease-resistant species from Europe.

The eagle, an important American symbol, is also in danger of extinction. Multiple observers show a decrease in young eagles and failures in egg-laying – data from Hawk Mountain, a bird sanctuary, and from Charles Broley on the western coast of Florida, a popular eagle nesting ground, is particularly dire. In 1947, when he began his survey, Broley found and banded 150 young eagles from 125 active nests. By 1958, he found only one young eagle after searching 100 miles of Florida coastline.

Dr. James DeWitt's experiments with DDT predicted this effect on bird fertility by studying quail and pheasants, and his results have been replicated by many scientists around the nation. The toxin is transferred across generations, causing sterility or early mortality in young eagles. These eagles would have come into contact with DDT because of their diet of fish, which often contain trace amounts gathered from the polluted waterways and their food supply.

Treating seeds with pesticide in Britain led to “a deluge of reports of dead birds,” and many there see insecticides as the biggest threat to wildlife of all time. Still, as the habit of pesticide use to ‘eradicate’ pests grows, some are targeting birds directly. A group of farmers in Indiana used parathion to kill 65,000 blackbirds and starlings. Who has the right to decide, on everyone else’s behalf, that such drastic measures are necessary?

CHAPTER 9: RIVERS OF DEATH

Carson begins with a nostalgic description of the idyllic salmon breeding grounds of the Miramichi, a river in New Brunswick, Canada. She describes their journey from the Atlantic upstream to their spawning grounds in rich detail, before revealing that pesticides have had a destructive impact here, too. Spraying to prevent the spread of budworm populations in Canada’s balsam forests doused millions of acres with DDT in 1954, including the Miramichi.

Again, Carson shows us a means of control that has been successful elsewhere, and which seems far preferable to the impossible choice between losing the famous American elm or the birds that live around it. Justifying the use of pesticides to save the elm is even more difficult given the lack of success that local sprayers have experienced with halting the advance of the disease, and mounting evidence of bird deaths.



By focusing on the eagle, Carson finds a means of relating the abstract dangers of pesticide use to a specific, much beloved symbol of American patriotism. The work of on-the-ground naturalists like Broley provides the basis for her arguments about their population decline – this research exists not because anyone from the chemical industry funded testing, but because Broley had a passion.



The science that explains this decline in bird populations already exists, but has not been taken seriously enough by those responsible for spreading chemical controls. Eagles, like every other species in nature’s web, are vulnerable to the accumulation of toxins in their environment and food supply. And as a top predator, eagles resemble humans as an endpoint of biomagnification.

Using the documented concerns of those in other nations to suggest that lawmakers in the United States, too, should take seriously the threat of pesticides, Carson contrasts this concern in Britain with the dreadful example of Indiana farmers who chose to use parathion in an instance of direct violence against birds, rather than indirect, unpredicted destruction. Carson, again, asks why a select few, with little oversight, should have the right to make such choices that will impact everyone.



Carson returns to her descriptions of a beautiful, idyllic, and uncontaminated past. She chooses an area that many Americans would consider to be a part of the deep wilderness, immune to the effects of human life, and shows that this immunity is a myth; aerial spraying has had devastating effects here too.



Errant spray killed trout and young salmon, but also wiped out the caddis fly larvae that they depended on for survival, so that returning salmon to the stream would not be easy. In the meantime, even repeated sprayings had failed to halt the budworm, and caused fundamental changes in stream life. Although a strange series of events surrounding heavy rainfall connected to Hurricane Edna led to an unusually good year for salmon in the Northwest in 1955, overall destruction across the region was massive, threatening the fishing industry's survival.

Continuing her chronicle of death in river systems, Carson mentions reduced salmon runs in Maine that are also associated with budworm spraying, and describes fish blinded by DDT who are so disoriented that they can be plucked from the stream by hand. She goes on to discuss contamination of the Yellowstone River from 1955-57, when dead fish lined the riverbanks and an oily film covered the water. Agencies studied the destruction caused by spraying 900,000 acres in that area and concluded by taking a pledge to cooperate to minimize losses in future control attempts.

In British Columbia, though, even after those engaging in spraying had agreed to cooperate with forestry services, having seen the negative effects spraying had had on the Miramichi, many streams were still disastrously affected. 100 percent of salmon were killed in at least four streams, and could only be repopulated by transplanting young salmon artificially, since salmon return only to the place in the stream where they were born.

The threat of pesticides to fish is threefold: direct spraying of forest streams with DDT, bleaching of chemicals into the water table, and pesticides that reach marshes and bays. Commercial and recreational fishing are seriously endangered as a result. Individual accounts from all over the country reinforce this danger. In Alabama, runoff containing the chemical toxaphene after heavy rains resulted in massive fish kills. Fish are very sensitive, and can be an indicator of the ways in which toxic chemicals persist in streams.

International examples, from Rhodesia and the Philippines, also illustrate the pervasive threat. In these countries, insecticides that inadvertently contaminate fishponds used to raise important stocks of local fish have a serious effect on the food supply. After a pond is infected, it is nearly impossible to remove all chemical traces.

The destruction of young fish, unintentional but foreseeable, had an effect on the local fishing industry as well. The changes wrought by spraying have upset the balance of this system, so that it is not simply a question of re-introducing salmon to the stream. Even if nature managed, by a random event, to recover in one section of the stream, the damage overall is unsustainable.



The image of a blinded fish, plucked easily from the stream, is a disturbing, unnatural one that contributes to the sense of a present and future apocalypse brought on by pesticide use. This destruction can reach even those areas that men have decided to protect, as Carson shows by citing the example of Yellowstone, one of the country's most popular national parks. Here, even sprayers seem to have acknowledged that all is not well.



Still, this acknowledgement is not necessarily enough to create change. The Canadian example shows that even relatively 'careful' aerial spraying is impossible to contain, especially when it enters the water table, which we have already learned is a complex, interconnected one that accumulates chemicals.



Carson first emphasizes the consequences of fish death for commercial fishing industries, and for the major segment of the population for whom recreational fishing is a common activity. In doing so she shows that pesticides – whose use is justified in that they should save money in the form of undestroyed crops – in fact can result in huge financial losses. Then Carson follows up that point by explaining that the deaths of these fish serve as a warning of the danger to humans as well.



Another reason to support the precautionary principle; evidence from all over the world demonstrates the interconnectedness of life, and the unpredictability of substances that are poorly understood when they are introduced into complex systems.



In 1961, contamination of the Colorado River below Austin, Texas led to massive fish death for 200 miles downstream before contaminated water was diverted into the Gulf of Mexico. Investigators discovered that a pesticide plant in Austin had been dumping chemicals for years – heavy rains from a recent storm had displaced deposits of these chemicals coating sewers, and the resulting runoff annihilated river life for hundreds of miles.

This is one of the most massive instances of fish death related by Carson. The image of carnage is difficult to shake. This is also the first instance in which chemicals have been seen, in one visible push, to have spread across hundreds of miles and reach a border or enter the ocean. That pesticides have this destructive power should be enough for the public to urge caution.



In 1955 on the eastern coast of Florida, in the Indian River country, 2,000 acres of salt marsh were treated with Dieldrin in an attempt to kill sandfly larvae. The treatment led to massive fish and crustacean mortality (20-30 tons of dead fish, or 1,175,000 individual fish). Sharks were seen swimming through the water, eating the masses of dead fish.

The second vulnerable area is salt marshes, and this example demonstrates why. Marshes are a system that spreads and recycles nutrients from the ocean, and so the introduction of chemicals leads to a natural spreading of the poison, causing widespread death.



This episode shows that research is needed to determine the effects of chemical runoffs at sea and in important estuary/salt marsh environments. These areas serve as the breeding ground for many interconnected species. Shrimp fry and plankton have been shown to be very sensitive to pesticides, even at miniscule concentrations of parts per billion, and they serve as a vehicle for bio-magnification that could pass poisons up the chain to human consumers, according to Dr. Philip Butler.

Here, for the first time, Carson considers the water system beyond its freshwater streams, arguing that the accumulation among plankton and shrimp of toxins could, as we have seen before, have unintended effects. These small organisms render 'acceptable' limits almost meaningless, since, in eating many shrimp or plankton, will concentrate its effects.



So much is unknown, concludes Carson, and these waterways are so vitally important, that the public should demand facts and the suspension of spraying in the meantime.

This is a call for caution, a call aimed directly at the voices of public citizens, who must participate in the defense of important waterways.



CHAPTER 10: INDISCRIMINATELY FROM THE SKIES

Aerial spraying of pesticides has very rapidly become common practice, and is largely unquestioned and indiscriminate. However, recent, disastrous campaigns - against the gypsy moth in the Northeast and the fire ant in the South – have caused some understandable public misgivings about such programs.

This is the method of pesticide use that seems most reckless in Carson's eyes, arguably; it resembles the distribution of nerve gas during World War II, but has suddenly become "normal" and is considered harmless.



Released accidentally in 1869, the gypsy moth spread throughout New England via wind and shipping. The Adirondacks and thirteen imported parasites and predators had successfully halted its spread further, but the Agriculture Department still called for widespread spraying with the goal of 'eradication.' By 1957, 3 million acres of forests, farmland, and suburban lawns were being sprayed despite an abundance of public complaints.

Yet again, Carson offers us a case of pest control in which natural methods had showed substantial success even before the decision to use pesticides. She mocks the attempt at 'eradication,' which is an unattainable and undesirable goal, from her point of view. There is no reason that a pest must be completely exterminated; it can be controlled by natural means.



Robert Cushman Murphy, a notable ornithologist, led a campaign against the spraying, seeking a court injunction. The movement was unsuccessful, but Justice Douglas wrote a dissenting opinion in support of their claims. After the spraying, on the Waller farm in Westchester, New York, although officials had assured the property owner that her holdings would not be sprayed, milk samples taken from cows on her farm showed DDT contamination. There is a lack of consumer protection from such polluted milk.

Paid by the gallon sprayed rather than by the acre covered, pilots hired to perform the spraying did so indiscriminately, with no regard for what was beneath them. As a result, unintended casualties on the ground were hard to avoid. Hundreds of bee colonies died and crops suffered without these vital pollinators. Overall, the program was disastrous, and was curtailed in following years. In a pattern that mirrors what we have seen before, the targeted gypsy moth reappeared in the area despite renewed spraying.

In the South, the fire ant, which Carson argues was not in reality a very important pest, and may actually have helped in controlling other pests more harmful to agricultural interests, became the focus of attention after an intensive propaganda campaign that resulted in a “sales bonanza” in pesticides. This included the production of a horror film depicting the terrible, and potentially deadly effects of a fire ant bite – even though the record of bites in the area was nearly non-existent. Despite widespread protests, *no research was done* before the launch of the million acre aerial campaign in 1958.

As we have seen in other cases, aerial spraying resulted in massive mortality in birds and ground animals, as well as livestock, throughout the Southern United States. Despite denials from the Department of Agriculture, ninety percent of dead bird specimens studied by the Fish and Wildlife Service contained residue of the sprayed pesticides dieldrin or heptachlor. Dr. Otis Poitevint, a veterinarian, saw many sick farm animals, including a calf that was exposed via his mother’s milk – and this raises new concerns about transmission to human children.

Carson uses polluted milk as a symbol of the dangers of contamination to man, and particularly to children. She documents the work of Cushman and Justice Douglas’ response in order to give readers the sense that there is a movement, which they might join, that already opposes the seemingly unchangeable world of the pesticide industry.



The incentives are for more destruction, not less; this is the ultimate idiocy of the aerial spraying method, it attacks the natural world without discriminating ‘good’ and ‘bad’, ultimately changing the natural world by removing vital members of the ecology, such as honeybees. Again, the moth’s return shows the futility of these methods.



Carson exposes the propaganda campaign as an effort designed to create an atmosphere of crisis that would justify intensive control using pesticides, even though fire ants were never especially harmful to crops. The lack of research shows a blatant lack of caution that ignores the interconnected nature of ecological systems. Fear and propaganda, argues Carson, have taken the place of coexistence and tolerance.



The inability of government agencies to acknowledge the widespread destruction their programs have caused shows an arrogant belief in their ability to control nature’s complexities, and an inability to take responsibility when that belief steers them in the wrong direction. In a world in which man does have the power to change his environment, it is especially important that he remain humble in the face of its careful balance.



In 1959, the FDA banned any residues of epoxide on food—this new regulation prompted the ‘discovery’ at the Department of Agriculture that, in 1952, biologists had found that heptachlor, the chemical most widely used against the fire ants, transforms into the more toxic epoxide after a short period in animal or plant tissue. Even though this data had existed for seven years, no one involved in the fire ant campaign seems to have done enough research before spraying began to notice it in the academic literature. Public officials subsequently pushed back against the spraying program, and it tapered off amid general outcry.

In the wake of the program, fire ants were by no means ‘eradicated,’ and in fact their numbers seem to have increased in some states. A return to more “sane” methods has occurred since the end of the aerial campaign, with selective, targeted chemical treatment of individual mounds, which generates only one quarter the cost of aerial spraying and is much less destructive to the surrounding ecosystem.

This is a staggering example of the lack of precaution and foresight being used by the pesticide industry, which ignored a known danger of heptachlor use, and a major point in favor of more bans and regulation on chemical usage, since this seems to be the only thing that the industry responds to with any urgency. It’s also another instance illustrating the unpredictability of synthesized chemicals in the environment,



After all of this damage to local ecosystems, the program’s mission – to eradicate fire ants – seems to have been a total failure. As in other cases, more targeted spraying has proven far more effective while avoiding the negative consequences of aerial spraying, which comes off as lazy, short-sighted, and expensive.



CHAPTER 11: BEYOND THE DREAMS OF THE BORGIAS

In this chapter, Carson examines the effects of modern life—which she shows now entails a slow, prolonged exposure to a constant drip of chemicals—on the state of human health. Frustratingly, from Carson’s perspective, these death-dealing materials of insecticides are marketed cheerfully to consumers, without traditional poison warnings.

The assortment of ‘helpful’ home products containing insecticide is vast, both for gardening and in the kitchen. It has become the norm to make use of such products, without a real awareness of their dangers. Fewer than fifteen people out of a hundred, according to a recent industrial film, read the warnings on their insecticide containers – which are often hidden in the fine print. This leads to the unwitting application of chemicals in the home that ought to be treated with much more caution. New attachments available for sale even allow you to spray chemicals straight from your garden hose, potentially contaminating water supplies.

The next few chapters will focus more on pesticides’ effects on humans themselves. Here, Carson’s frustration is linked to a sense that the public is being misled, and that substances that would in the past have been thought of unambiguously as poisons are now tools in man’s everyday war against nature.



The normalization of pesticide use – the sense that pesticides are just everyday simple tools that everyone uses – shows a lack of public education, but also a general acceptance of the idea that man can – and should – shape his environment according to what seems most convenient. This rush toward aggressive methods of control shows a lack of precautions that ought to take precedence when one is dealing with a set of serious poisons. Carson asks rhetorically: Is this the responsibility of the individual consumer, or those who produce and market these products?



Acceptable levels of pesticide residue on food are fiercely debated. While those who object to chemical residues are branded as fanatics, DDT has been found everywhere in produce and in cooked restaurant meals. Surely this is cause for alarm? The Eskimos on the far Arctic shores of Alaska are perhaps the only people free of pesticides – but even there, now, samples taken from Eskimos who had visited a hospital in Anchorage have revealed the contamination common to modern life.

Misuse of pesticides by farmers is acknowledged even within the chemical industry, where publications warn against repeated spraying in short periods of time or careless overuse that seems to be widespread. The FDA, however, is severely limited in the field of consumer protection because it has jurisdiction only over foods shipped across state lines. As if that weren't limiting enough, its small staff is only able to inspect less than 1% of crops sold in the United States.

The system as it stands is broken – our daily existence is like being a guest of the Borgias, that infamous family of Italian poisoners. Residues of different chemicals mix in our meals with unpredictable results and are cumulative, so the concept of a 'safe level' of tolerance for any individual chemical is useless and should be eliminated, as it only provides a false sense of security to the public. These rules should be enforced by a much more powerful FDA, and will require public education to become effective.

CHAPTER 12: THE HUMAN PRICE

This new tide of chemicals represents a drastic change in public and environmental health. Instead of infectious diseases like smallpox or cholera, we are concerned with those potentially harmful things in our environment – like radiation and chemicals – that we have introduced into the world ourselves. They have the power to render the world uninhabitable, “**silent** and birdless.”

Because of the hard to see, unpredictable, and delayed effects of absorbing small amounts of pesticides over time, it can be easy to ignore the problem. Humans seem programmed to shrug off disasters in the distant future, concerned only with those effects that can be seen immediately. Still, we are vulnerable in the same way the robins were, as part of an interdependent system that scientists call ecology. Whenever some part of this ecology is disrupted, its potential negative effects on the other parts are difficult to predict.

It is truly a new era when no one living can be said to be born into a world without chemicals, since the present world of chemicals is entirely a product of man's choice to change his environment – a choice whose consequences cannot be isolated and are not understood. We have acted rashly, implies Carson, but any hint of skepticism or caution is met with strong resistance by the mainstream promoters of pesticide use.



This tendency toward misuse is another point in favor of stiffer regulations or bans, since individual farmers will always, according to their own sense of self-interest and in response to the all-too-effective marketing campaigns of pesticide producers, seek to maximize the productivity of their own farms in what is a precarious industry. Those tasked with enforcing regulations now are woefully underfunded.



The public must understand the dangers that it faces – and by making use once more of a reference to the infamous Borgias, Carson further emphasizes that these 'harmless' products should be thought of as deadly poisons. The government's current approach is underfunded and lulls citizens into a false sense of security that discourages action to ban pesticide residues outright.



Carson's contributions to our modern understanding of environmental health cannot be underestimated. She provided an early platform for the idea that, in this new era, the greatest threats to human health were the toxins created by humans themselves. This is a warning to the public, whose awareness of the dangers of radiation should be extended to dangerous pesticides.



The difficulty of prioritizing future threats is one that must be overcome by reliance on the precautionary principle. The best way to understand the danger is to look at what pesticides have already done to the natural, inescapably interconnected systems of which we are a part – this has been Carson's goal since the beginning of the book.



The human body itself contains a delicate ecology, where cause and effect are difficult to pin down – doctors are hard pressed to understand exactly what symptoms are a result of what lifestyle choices or genetic predispositions. It is therefore difficult to know when or how an insecticide might leave its mark on your system. Many pesticides are stored in fatty tissue and can accumulate over years, only to be unleashed in a stressful situation when fat is burned to release energy. British experimenters, who used their own bodies as test subjects, found that a small, direct exposure to DDT caused tremors and aching for an entire year.

The liver is a vital part of this body ecology, and the first line of defense against poisons. Anything that could disrupt the liver, then, would greatly increase our vulnerability to environmental toxins. Methoxychlor, for example, is absorbed 100x faster when found in combination with another chemical that handicaps the liver.

Sensitivity to synthetic pesticides varies from person to person, and seems also to vary depending on previous exposures to a given chemical. With each renewed contact, symptoms can return or worsen with exposure to smaller doses. Moreover, unlike in laboratories, no chemical in real life is ever encountered alone, and, as we saw with the discussion of polluted streams and waterways, the effects of the interaction between them are largely unstudied.

Pesticides' effects on the nervous system are long lasting and little understood. During prohibition, a bootlegged alcohol substitute called Jamaican Ginger included a chemical in the family of organic phosphates. 15,000 people developed a crippling paralysis as a result of drinking this particular moonshine. The same type of paralysis was seen again when pesticides came into use two decades later. In clinical work from the University of Melbourne, pesticides were subsequently linked to mental disease as well – “a heavy price to pay for the temporary destruction of a few insects.”

CHAPTER 13: THROUGH A NARROW WINDOW

If we narrow our focus, we can see the effects of pesticides on the workings of individual cells. Recent medical research shows that energy production via cellular oxidation happens on a cellular level to fuel the body. A prizewinning roster of scientists have over the last quarter century been gradually uncovering the secrets of this beautiful mechanism, which Carson refers to as “one of the wonders of the living world.”

By comparing the systems within the human body to the natural ecosystems she has already examined, Carson brings the awareness of relationship and dependency to a human level. Her health warning is deliberately frightening, and a main feature of her argument continues to be that so much is unknown or poorly understood, that it seems to make sense to slow down and conduct more research. The evidence we have is enough to know that the danger is real.



Just as she has demonstrated the potentially disastrous effects of chemicals that interact and are transformed by their environments in the wild, Carson here relates this danger to human health by showing how certain chemicals can cripple natural defenses.



Given the prevalence of chemical residues, which Carson has already outlined in the previous chapter, we are all vulnerable to these prolonged exposures – this is another point in favor of rethinking the current idea about tolerable levels of chemical residue on food. The interconnected, messy, complex world is just too difficult to simulate in a laboratory setting, where these limits are established.



As with her reference to the Borgias, Carson makes use of an infamous event from history to illustrate the poisonous nature of pesticides. Is it not strange, given the storied harm of these substances, that they should be allowed to invade our present and future so easily? Learning from the example of history should suggest that caution and research are required before undertaking such a risk.



From the macro scale of entire ecosystems, Carson has narrowed her focus first to the human body and now to the functioning of individual cells. This is part of her project of education, as she gives a popular voice to the work of scientists around the world. That pesticides could affect our bodies on even this cellular level is another reason for treating them with extreme caution.



ATP and ADP, the body's units of energy, are produced in minute structures called mitochondria within each cell. After ATP is used as energy, it loses a group of atoms called a phosphate and becomes ADP. This ADP is then recharged in turn by a process called "coupled phosphorylation," in a carefully coordinated string of enzyme reactions. Radiation and synthetic chemicals both have the frightening power to uncouple this fundamental process, causing the body to burn itself out. This uncoupling power, which Carson calls "the crowbar to wreck the wheels of oxidation," is present in many pesticides.

The disruption of the oxidation process has an effect on fertility that is visible in eggs and other germ cells in animals – this might explain the sterility that has been observed in birds after exposure to DDT. If pesticides prevent ADP from coupling with a new phosphate group, respiration continues but no energy is created, so that the body uses power without creating any. Because ATP is "the universal currency of energy," the driving energy force in life everywhere, its disruption in other species is a sign that humans can also be affected. We are not immune.

Carson returns to the plight of the birds, recalling the sterile blue robin eggs and the larger, white eagle eggs, "cold and lifeless." Observations of DDT levels in unhatched bird eggs have shown unsafe concentrations, which according to scientists' understanding of the oxidation process outlined above would have disrupted the proper production of ATP and crippled development of fledglings.

Humanity's "genetic heritage" is also under threat, in a way that mirrors the problems of radiation, which can cause mutations that are passed down over generations. Cell division, or mitosis—the process by which one cell divides into two—is another universal process in the natural world that is affected by radiation and by mutagens, including common pesticides. Mitosis involves a careful alignment of chromosomes, which are the structures made up of DNA, so that all the genetic information is split evenly between two daughter cells. This process may be 1000 million years old, and is part of what has allowed life to flourish.

Again comparing the well-known effects of radiation to those of pesticides, Carson explains that even the process that is perhaps most fundamental to life, the production of energy in cells, is in fact another instance of the 'complex system' carefully calibrated by nature. Here, too, pesticides have the power to disrupt a careful balance, and the body is not designed to combat them, since their development has been so rapid compared to the pace of evolution.



By linking this examination of the process by which cells produce energy to sterility in birds, Carson is driving home her point that humans are vulnerable to the same harm that we see affecting the natural world. ATP, the energy unit at the core of this process, is universal, and so its effects in other species will be mirrored in humans – just as it was with the sprayers, early in the book, who were paralyzed by a new malarial spray.



The problem of sterility is a chief factor in the decline of these emblematic bird species, and this understanding of the cellular energy production process offers one explanation – again suggesting that the same sterility could strike humans with the right level of exposure to DDT.



*Equally alarming are the effects of pesticides on cell division, another process that is universal across the world of living creatures, meaning that disruptions in one species – of fish, for example, who often suffer mutations from their chemical environments – could be mirrored in humans. The danger of mutations is associated with nuclear radiation – which was a huge topic at the time that *Silent Spring* was published, coming in the midst of the Cold War and just a few decades of the dropping of the atomic bombs. Carson captures the urgency of the pesticide issue by making it clear that pesticides, in their dangerously rapid development, pose a similar threat to nuclear radiation in the way they affect cells.*



Anything that disrupts the accuracy of this age-old process could change the course of evolution and cause disease in individuals of a species. Although the study of human chromosomes is in its infancy, we can see the effects of pesticides on cell division in other species of plant and animal, and predict their results in humans. Chromosome abnormalities like those we see in animals as a result of pesticide exposure are known to cause many issues in humans, including hereditary disease, sterility, and cancer.

Evolution is often thought of as the ultimate, abstract safety mechanism on a species wide level – it allows populations, on a longer time scale, to adapt to changing environments or new diseases. Crippled by a lack of time, however, and now attacked directly in the process of cell division, evolution may not be able to protect humanity any longer. That humans can now influence this process on such a scale is shocking enough – are we arrogant enough to assume that we know better than this ancient system at the heart of life?



Far too little is known about the effects of pesticides on cell division, but it is clear that disruptions in chromosome replication are responsible for a wide range of mental and physical illnesses. These dangers are widely discussed with regard to radiation, but the potential for chemicals to cause mutations is underappreciated and has not been sufficiently studied. It seems absurd, argues Carson, to continue exposing ourselves to such a potentially dangerous cocktail of chemicals for so little benefit.

If exposure to pesticides can cause mental and physical illness – and Carson has provided ample evidence that it may – then are we not responsible as a nation, or even as a species, for halting the advance of these dangerous chemicals? Carson makes the case that a basic level of caution is needed to prevent a future in which man creates his own downfall by continuing down his current path.



CHAPTER 14: ONE IN EVERY FOUR

This chapter takes up the question of pesticides' carcinogenic (cancer-causing) effects. The first awareness of environmental cancer-causing agents was in 1775 when Sir Percivall Pott made the link between scrotal cancer in chimney sweeps and the arsenic laden soot that they interacted with so much as part of their jobs. Arsenic was also found to cause cancer among copper smelters and mine workers during the early days of the industrial revolution. As the industrial era progressed, more occupational exposures to industrial chemicals were identified as cancer-causing.

Cancer, like the dangers of radiation, was an issue of increasing concern in Carson's time – as it is now. This brief history of industrial carcinogens provides context that many of her readers would have been aware of to some extent. She will extend this public awareness further. The idea of cancer-causing synthetic chemicals, of man-made disease, is tied up in the new era of man. Humanity's new power has unexpected and sometimes negative effects.



In the modern era, exposure is no longer merely an occupational hazard, but rather an environmental one—we are all vulnerable wherever we go, exposed to rapidly increasing number of carcinogens. Cancer rates are rising, argues Carson – 45,000,000 Americans now living will develop cancer at some point. Children, for whom cancer was a rarity as recently as a quarter century ago, are also increasingly vulnerable, with more children dying of cancer in America than any other disease. The question is: could the pesticides we are using to try and control nature be one cause of this increase?

This shift that Carson signals, from dangers faced by workers in particular industries to environmental dangers that affect everyone, is a key part of our modern understanding of health risks. Exposure is no longer the result of any choice - about where to work, how to process materials, etc – but rather a fact of modern life, to which everyone submits. This could explain why even children are now being affected by rising cancer rates, although they have never worked in an industrial setting. How can we assign responsibility in this new era?



The circumstantial evidence is compelling. A monograph by Dr. Hueper tells the story of Reichenstein, a mining city in Silesia, Germany, where arsenic waste had accumulated near mine shafts and contaminated streams. This exposure caused disease and cancer, as has also been seen in Córdoba, Argentina, where arsenic leaches from the rocks. We may be creating the same circumstance for ourselves by using arsenic based pesticides and polluting streams. In Saxony, in Germany, arsenic fumes from smelters caused environmental degradation reminiscent of those accounts of pesticides recounted in previous chapters.

Arsenic is not the only carcinogenic pesticide, however. One chemical widely used against mites and ticks is an example of ways in which slow-moving legal processes can allow cancer-causing agents to remain in use even though danger is suspected. Although the FDA's scientists had interpreted initial testing of the pesticide as possibly cancer-producing, the chemical's manufacturer filed an appeal of their initial ruling of 'zero-tolerance' for crop residues, and the committee's decision was changed to a tolerance of one part per million, an unenforceable level that essentially made the public into unwitting guinea pigs.

Even after the chemical's cancer-causing effects were further confirmed by testing with lab animals two years later, it took another year of legal work before the tolerance level could be reduced back to zero in 1958 – and the agency's ability to enforce this level is open to questions.

Dr. Hueper also rates DDT as a carcinogen, and two herbicides (IPC and CIPC) have been shown to produce skin tumors in mice. The FDA found aminotriazole, an herbicidal chemical widely used by cranberry growers, to cause thyroid cancer at any level of exposure, and subsequently seized contaminated berries. Some questioned this choice, but further testing confirmed that more than half of lab rats exposed to the chemical at a rate of 100 parts per million in their drinking water developed tumors.

15-30 years of latency may pass between exposure to a carcinogen and development of disease, so the full maturing of the threat has yet to arrive. Leukemia has a shorter latency period, and anecdotes show chemicals have a causal relation to all types of blood and lymph diseases, which are on the rise at a rate of 4-5% each year. Dr. Hargraves sees an unmistakable link between these blood diseases and environmental exposure to toxic substances.

In the instances recounted by Dr. Hueper, arsenic built up in the environment either naturally (in Argentina) or as a result of industrial practices (in Silesia). It is chilling to imagine that these hot spots of arsenic poisoning may become the norm, as arsenic based pesticides are used in a wide range of environments and spread via the water system, as we saw in chapter four. Man has created this risk himself, and the public must recognize its danger before it is too late.



This is another example of the ways in which financial incentives can override safety concerns, so that instead of using caution we see chemical manufacturers forging ahead in pursuit of profit. The responsibility for this oversight is shared by the manufacturer and the regulatory system, and the public served as guinea pig for both. In an era when man's creations have the power to cause cancer, a stricter moral responsibility and principle of precaution must apply.



The political and legal system, even in the face of definite evidence, is too slow to combat the rapid proliferation of dangerous, cancer-causing chemicals. The public must demand a new system.



There is enough evidence to justify a radical new approach to the regulation of chemicals, one that is based in the precautionary principle and safeguards future generations against the dangerous substances with which we are poisoning our present. More power of the environment in this new era also requires a more careful, responsible approach to its management.



Carson's suggestion of future, unknown dangers is meant to shift priorities within the public, giving people a reason to think cautiously about the long-term. As a demonstration of the potential long-term dangers, the increasing frequency of leukemia and blood diseases can serve as a warning sign that should not be ignored.



Carson recounts a series of cases in which exposure to DDT seems to have led to the development of cancer. One housewife who sprayed repeatedly against spiders with DDT died of acute leukemia. A business man embarrassed of the roaches in his building used a 25 percent DDT concentrate to spray the basement, quickly developing internal bleeding and received 59 transfusions over the next six months. He recovered, but died nine years later after the development of leukemia. More cases from around the world support the causal link between pesticides and leukemia.

Researchers must again examine the body on a cellular level to understand cancer's origins. Professor Otto Warburg believes that when respiration is disrupted in individual cells, which can happen as a result of pesticide exposure, the race to compensate might cause cancerous growths. Another theory suggests that disruption of chromosome replication, another effect of pesticide exposure, causes unregulated cell division, a hallmark of cancerous growth. Exposure that disrupts the liver's normal workings can also cause estrogen to accumulate in a way that might stimulate the growth of cancer cells.

Again, Carson emphasizes that interactions between chemicals that are now omnipresent in the environment may also amplify their carcinogenic effects, and radioactive contamination could also change the nature of individual chemicals. We cannot know the full extent of these dangers with certainty, but the development of cancer in fish is an early warning sign for human health, as Dr. Hueper notes.

Dr. Hueper believes that, just as the previous generation of medical researchers found success eliminating disease-carrying pathogens and focusing on prevention, we must work to clear our environment of the carcinogens with which we are populating it on an increasing basis. This will be more effective than a magic bullet 'cure' for cancer. There is hope. Since we have created these carcinogens, we can also eliminate them from our lifestyles if we act collectively.

CHAPTER 15: NATURE FIGHTS BACK

The ever-shifting balance of nature is threatened by modern insect control programs, which cannot foresee their complex effects on a living community of interdependent creatures. In fact, the 'resistance of the environment,' of natural predators and prey operating in a system of checks and balances, is the only really effective, natural measure for fighting infestation, and this natural resistance is only *weakened* by indiscriminate spraying. And so the final irony is that, even as we have risked so much in an attempt to control nature, our efforts have inevitably failed.

By returning to the anecdotal level, Carson makes her abstract claims about carcinogens frighteningly relatable. Each of these people was uneducated as to the real dangers of pesticides, treating them not as poisons but as any other household product. The use of pesticides has become normalized, so that people don't even consider that they might be dangerous, but Carson is working to undo that sense of normalcy that has been attached to these poisons.



Here, Carson recalls the fundamental, universal processes that were explained in the previous chapter: energy production and cell division. Disruptions to one or both of these processes might be at the root of cancer, and we have already seen that pesticides can provide that disruption. By listing the various theories, Carson also emphasizes how little is known for certain, a common theme used to encourage caution and research.



The interconnectedness of nature allows us to take the effects of carcinogens on one species – in this case fish – as a sign that humans could be affected. Carson again uses the warning bells of nuclear radiation to her advantage, and urges caution in the face of unknown dangers.



The optimism here is a welcome change – even though man has created the new era of environmental disease, it is also within his power to end it. However, the public must take collective responsibility if it hopes to avoid a future in which cancer is omnipresent. We should avoid the temptation of the easy way out, and stop relying on development to find a cure.



When birds and other predators are destroyed by pesticides, the natural system of checks and balances is disrupted in ways that isolated testing failed to predict, so that pest populations boom. Although we have the power to change our environment, we are not doing so in a way that humbly admits the enormous quantity of information we still do not know about the complexities of ecology.



Natural population dynamics are complex and carefully calibrated. When natural predators of Kaibab deer in Arizona were killed off in a conservation effort, the population of deer ballooned and then collapsed from lack of food. Insects, too, have this system of predator/prey checks and balances which results in a careful balance. Carson lists a number of examples, from dragonflies to ladybugs to wasps, whose incidental destruction from broad, blanket spraying actually ended up leading to a *ballooning* of the originally targeted pest population.

This phenomenon explains why after sprayings pests have been seen to rebound massively, as Carson proves with accounts from all over the world. Blackflies in Ontario became 17 times more abundant after spraying was completed. The spider mite has become a worldwide pest since DDT has killed off its natural enemies, attacking evergreen trees with its voracious appetite for chlorophyll, which makes leaves green. This happened in 1956 when western national forests were sprayed with DDT after a budworm infestation, and the following summer brought a blight of brown trees.

Conversely, imported natural predators have shown good results in reducing populations – until they themselves are eliminated by pesticides. In California, great success with an inexpensive biological control involving a parasite of the destructive scale insect was reversed when spraying killed off the parasite, a small ladybug called the vedalia. New methods are more expensive and destructive, and less coordinated.

This effect is still more sinister when considered in the context of disease-carrying insects. Mosquitoes that carry malaria flourish from a lack of predators after chemicals are applied, unless pesticides are re-applied year after year. Snails, which can transmit parasitic worms, seem to be immune to pesticides, and their numbers increase when their natural predators are killed off by sprayings.

Despite the seeming folly of pesticides and the promise of biological solutions, research into chemical options for control of “pests” far exceeds that for biological ones. One reason is that insecticide companies endow fellowships and research, but no corollary exists for biological control. Dr. A.D. Pickett is one exception, pioneering natural methods and minimizing the damage of specifically applied, gentler pesticides. He denounces indiscriminate spraying, describing it as a route to crisis after crisis.

This is a perfect example of these complexities, and of the ways that man’s attempts to intervene, to re-engineer a pre-existing system, can easily backfire in unexpected ways. What we can expect is that intervention, without proper research, and especially in the unintelligent, indiscriminate form of blanket spraying, will change the natural balance in some way, and perhaps dangerous ways.



The record of man’s attempted interventions seems to prove they are foolish. Over and over again, the interconnected, complex ecology into which pesticides enters is changed in such a way that the targeted pests are actually allowed to thrive! By spreading this message to the public, Carson is clearly aiming to motivate a change in the everyday citizen’s understanding of pesticides and their effectiveness, weighed against the dangers they pose.



Following nature’s example by taking advantage of the web of checks and balances, importing predators and parasites to deal with ballooning pest populations, is a much more sustainable and effective option. This is what the new era of man should look like.



Another unintended consequence of intervention into the interconnected system of nature is the spread of disease, when pests that carry pathogens are allowed to multiply without their natural predators. We must protect ourselves from this danger by exercising caution.



To break out of the pattern of crises that justifies spending on pesticides, we must invest in biological solutions, which Carson has shown are more compatible with ecological communities. Unless we as a species want to live on the edge of survival – struggling just to survive – these biological controls must be publicly supported as a replacement for pesticides.



CHAPTER 16: THE RUMBLINGS OF AN AVALANCHE

As Charles Darwin predicted with his theory of evolution, the fittest have survived: pests are getting stronger and more resistant with incredible speed. Many of the insects developing immunity to pesticides carry infectious diseases. Awareness of this problem has been slow to spread, but resistance among insect populations has not. Dr. Charles Elton called this issue “the early rumblings of what may become an avalanche...”

Organizations combating disease-carrying insects are acutely aware of the problem. Carson lists cases of resistance among mosquitoes, ticks, houseflies, rat fleas, lice, and many more, each of which can carry a different infectious disease. This issue must be dealt with, but it seems questionable to choose a solution that seems to be rapidly worsening the problem instead of a more natural option.

Cases everywhere from Egypt to the United States demonstrate that pesticides are in nearly every case only a temporary solution to a serious problem. Perhaps the first medical use of pesticides occurred in Italy in 1943, when DDT dusting was used to control against typhus carrying mosquitoes. Within one year, mosquitoes of a particular genus had begun to show resistance to DDT. In 1948, Chlordane was added to the chemical cocktail, and achieved good results - until flies and mosquitoes developed resistance to it two years later.

This pattern is repeated around the world. In Korea, and many other countries, lice have become completely resistant to DDT. In fact, individuals tested in Korea actually had more lice after the application of DDT. The rate at which insects develop resistance is also remarkable. In 1956, the number of mosquito species displaying resistance was only 5 - by 1960 this number had increased to 28, including carriers of malaria in West Africa, the Middle East, Central America, Indonesia, and Eastern Europe.

In dealing with upsurges of cockroaches, ticks, mosquitoes, and more, in regions from Central Park West to Indonesia to Iran, control agencies are currently cycling through pesticides as insects develop resistances. The same story is seen in insects that threaten agricultural crops - spraying only strengthens pests. The chemical industry wishes to ignore resistance, but mounting costs betray the increased difficulty.

This chapter outlines a new aspect of Carson's argument against pesticides: the rapid development of immunity to the pesticides among insects. Nature has trumped man's reckless attempts at control, so that the 'new era' in which man can influence his environment has developed almost into a war, as Carson will demonstrate here.



In areas where control is necessary because of disease, the use of pesticides has backfired as insects gain immunity to more and more chemicals. Underestimating the power of nature to adapt has led man into a situation where escalation of the 'war', that is, the development of more and more dangerous chemicals, seems necessary.



Since the very early days of pesticide use, the development of immunity in targeted insects has been observable. But rather than stopping to question how this cycle will end, scientists and controllers have created and used increasingly toxic chemicals in an attempt to overcome the immunities - only to see nature respond with more resistance. Caution, rather than automatic escalation, is required.



As Carson demonstrates, the problem of immunity is a difficult one to address. If the public knew about this wave of resistance - and once Carson's book has been published the public will know - perhaps they would be more cautious in developing ever-stronger chemicals. Instead, currently caution has been thrown to the wind in the pursuit of control over "pests" and nature.



This escalation of pesticide toxicity is like an arms race, in which two opposing sides continue to one up each other until something gives and destruction follows. The problem is that the increasingly deadly weapons that we are deploying are not targeting only the insects, but also disrupting the natural system and, in the end, causing illness in humans.



It is the process of natural selection, in which only the strongest (or most resistant) members of a sprayed population survive, that leads to this problem. These resistant individuals then reproduce, and their genetic material becomes dominant. The short life spans of insects allow these adaptations to take effect quickly across a broad population. The development of more and more toxic pesticides is accelerating as older models become ineffective against resistant insects.

This endless escalation resembles an arms race, in which two sides compete to develop more advanced weaponry, and end up with an arsenal of destructive forces that cause more harm than good – it is difficult to see a positive conclusion to this competition. More officials like Dr. Briejer, Holland’s Director of Plant Protection Service, are now calling for a reduction in spraying as a result of these dangerous dynamics. Life is a miracle beyond our understanding, writes Carson, and requires reverence and humility rather than scientific arrogance or pride.

CHAPTER 17: THE OTHER ROAD

Carson makes reference to the well-known Robert Frost poem “The Road Not Taken” to urge her readers to take the road “less traveled by” instead of the smooth superhighway of modernity, which leads down the path of escalating aggression against the natural world, which could backfire on humanity. She argues that the public has a right to know the frightening risks associated with chemical controls.

As an alternative, she suggests that it is our responsibility to choose the path of caution, of *biological solutions* based on careful research and ecological understanding. The availability of these biotic controls is growing as more researchers join the quest to replace pesticides with a smarter option. Carson goes on to summarize these new options.

Dr. Edward Knipling has developed a ‘male sterilization’ technique, in which sterilized males of a species are released and gradually outcompete wild males until only infertile eggs are produced. He conducted a successful proof of concept on the island of Curacao, eliminating the native screw-worm population after releasing thousands of sterilized males from a plane. The program was then replicated on a huge scale in the Southeast, with great results.

While insects can adapt quickly to new poisons in their environment, and have, humans have longer life spans and are therefore less genetically flexible – as we have seen, evolution may no longer be a safety net for the human race. In the pesticide arms race, humans lose out while insects continue to become stronger.



Here Carson makes clear her comparison of the dynamic between insects and pesticide manufacturers to an arms race. This arms race will lead to an extremely fraught future, as man struggles to keep up with the pace of his own development with dangerous consequences for the fragile balance of the natural environment, as we have already seen. This is as much a moral question as it is a scientific one.



Referencing Robert Frost, whose poetry celebrates the beauty of the rural Northeast that Carson, too, loves so dearly, creates a nostalgia for the beauty of the past, before this modern era of chemicals and combat against the natural world began. Carson directly challenges the public to choose between these two alternatives.



After an entire book dedicated to the many dangers of pesticide use, Carson will devote this last chapter to a discussion of safer, more natural alternatives that take into account the interconnectedness of nature. She leaves it for the public to decide which is better.



This is an example of a carefully targeted alternative, which in contrast to pesticides would have fewer consequences on other parts of the natural community. It is still a celebration of science and the future of human development, but development in the model of nature, rather than that which attempts to supersede it.



Following the success of Knippling's work there has been a rush to develop chemosterilants that would have a similar effect as the x-rays that he used to sterilize males of the species. However, new chemicals that would be released widely must be treated with extreme caution. There have also been experiments with synthesized hormones and defensive secretions that would be more targeted than general pesticides. Synthetic sex attractant for gypsy moths, for instance, is being deployed to disorient males during mating.

Still more methods are under examination; some researchers are working with ultrasound waves, while others have developed disease vectors that are meant to be extremely species specific, as previously discussed with the milky spore disease and the Japanese beetle in Chapter 7. Carson confidently asserts that these microbial insecticides are harmless to all but their intended targets.

And, of course, there is the option of biotic control involving imported predators or parasites. Beginning with the vedalia beetles brought to California by Alfred Koebele in 1888, there is a long history of successful importations that save millions of dollars each year. Still, biological methods are underutilized outside California. Opportunity is greatest in forests, where support for natural predators like spiders, small mammals, and birds in Wurzburg and Canada has been shown to allow for a pest-resistant, balanced ecology as it was meant to be.

So, there exists a whole battery of alternatives to pesticides if we can make the choice to forego the flashy, arrogant chemical option. Carson compares pesticides to the crudeness of a caveman's club, a barrage "hurled against the fabric of life." Nature, she concludes, does not exist for the convenience of man, and cannot be controlled by him. We must not turn our modern and terrible weapons, in ignorance, against the earth that supports us.

These chemical alternatives are at least not explicitly poisons, and although they must be deployed with caution and proper research into their effects on the surrounding environment, they offer access to a vision of the future in which blanketed spraying, which affects entire communities indiscriminately, could become a thing of the past.



Continuing her mission to educate the public about other options, Carson recalls the success of milky spore disease in controlling the Japanese. Although modern ecologists, with more research and knowledge at their disposal than Carson had when she wrote the book, would likely argue that her support of these methods seems to fail to acknowledge the dangers to the balance of an ecosystem that eliminating any member of the community can bring, her optimism is understandable relative to the intensely destructive methods of chemical control.



Returning to one of her favorite alternative models, Carson again explains the ways that importing predators or strengthening other natural checks can allow the system to correct itself, bringing pest populations under control in the way that a millennia of evolution has already provided for. Again, modern ecologists would argue that careful research is required before the introduction of any foreign species – and might argue that there are even better ways to control "pests" than to rely on using either man-made chemical control or non-native species in efforts at biological control – but Carson's basic optimism about this tactic is more of a reflection of her attitude toward nature and man's place within it: that man belongs within nature, and not trying to control it.



Carson argues that pesticides, although a tempting reflection of man's newfound power in the world, have inflated our sense of that power to a point that will lead to our destruction. If we cannot return to a place of respect for nature and the complex systems that it contains, Carson argues that we are hurrying rapidly toward a future without many of those things that have been essential to the experience of being human, and that it is our collective responsibility to exercise caution, conduct research, and slow down the pace of development to preserve our world and save ourselves.





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