# The New ECONOMY OF NATURE

The Quest to Make Conservation Profitable



Gretchen C. Daily

Katherine Ellison

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The Quest to Make Conservation Profitable

> Gretchen C. Daily and Katherine Ellison

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The New Economy of Nature

For Gideon, and for Jack, Joe, and Joshua, with love. The New Economy of Nature

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# Prologue

# The Wealth of Nature

"Nature's first green is gold."

-Robert Frost

When three-year-old Becky Furmann got the "poopies" and became dehydrated, her doctor urged her to drink water. He had no way of knowing that water had caused the rare illness that would kill her. As the chubby blond child grew thin and pale, her sufferings were finally confirmed as the ravages of *Cryptosporidium parvum*, a parasite almost unheard of until April 1993, when it slipped through one of the two modern filtration plants in Milwaukee, Wisconsin, and entered the city's water supply. Becky had been born with human immunodeficiency virus (HIV), which weakened her immune system, yet she had seemed otherwise healthy until then. Cryptosporidiosis sealed her fate. "She tries to ask us to kiss it and make it better, and we can't," said her father, near the end.

In all, Milwaukee's cryptosporidiosis epidemic led to more than 100 deaths and 400,000 illnesses. The victims had been betrayed by their water—and by their faith in the technology keeping it safe. What's more, they had plenty of company throughout the world.

With the start of the twenty-first century, every year more than 3

million people were dying of diseases spread by water, and another I billion were at risk, lacking access to water suitable to drink. As Milwaukee's disaster showed, the problem wasn't limited to developing countries. Some 36 million Americans were drinking water from systems violating United States Environmental Protection Agency (EPA) standards. One million Americans were getting sick every year from the contamination, and as many as 900 were dying from it. Fecal bacteria, heavy metals, arsenic, and pesticides had become familiar ingredients in many U.S. water supplies, and, as happened in Milwaukee, sometimes the highest-technology methods couldn't keep the contaminants out. Breakdowns were becoming a serious problem as mechanical systems aged and many strapped local governments deferred maintenance, to the point that the American Water Works Association estimated it would cost \$325 billion to rehabilitate the country's dilapidated mechanical systems to ensure safe drinking water for everyone.

This crisis, and particularly this specter of expense, led the city of New York in 1997 to embark on a bold experiment that would reveal the value of what had been a mostly hidden but huge gift of Nature. With billions of dollars and the drinking water of nearly 10 million people at stake, planners weighed the costs and benefits of two alternative solutions to their water problem—constructing a filtration plant or repairing the largely natural filtration system that had been purifying the city's water all along. Nature won. And in a turn of events that would have global implications, it won on economic grounds.

The battlefield on which this victory was achieved is the Catskill/Delaware Watershed, the heart of New York's purification and delivery system, named after the two major rivers flowing from it. The rural landscape is famed as a scene of great beauty, with sunstruck slopes, glistening streams, and trees that explode in color each fall. Less well known is that it's also a highly efficient and valuable machine.

The cogs are 2,000 square miles of crop-filled valleys and moun-

tains blanketed in forest, all connected by meandering streams feeding into an extensive system of nineteen reservoirs. For nearly a century, the complex natural system has been delivering water of exceptional purity to the people of New York City and several upstate counties. In recent years, it has produced as much as 1.8 billion gallons per day, serving New Yorkers with a healthy drink whose taste and clarity have been the envy of mayors throughout the United States. And unlike the case in most other large U.S. cities, New York's tap water has never passed through a filtration plant.

Instead, the water, born as rain and melted snow on mountaintops as far as 125 miles away from those who will ultimately drink it, is naturally cleansed as it makes its way downhill toward the reservoirs. Beneath the forest floor, soil and fine roots filter the water and hidden microorganisms break down contaminants. In the streams, plants absorb as much as half of the surplus nutrients running into the waterway, such as nitrogen from automobile emissions and fertilizer and manure used on nearby farms. In open stretches, wetlands continue the filtering as cattails and other plants voraciously take up nutrients while trapping sediment and heavy metals. After reaching the reservoirs, the water is further cleansed as it sits and waits. Dead algae, floating branches and leaves, and remaining particles of grit slowly sink to the bottom. Some pathogens left in the water may bind to the grit and settle, too.

This mostly natural process—supplemented by small doses of chlorine and fluoride at the end of the water's journey—worked beautifully for most of the twentieth century. But then signs appeared of some mechanical failures. The trouble was relentless new development: roads, subdivisions, and second homes were popping up all over the watershed, most of which is privately owned. Failing septic systems were leaking raw sewage into streams. Farming and forestry were also taking a toll, with lawn chemicals, fertilizers, pesticides, and manure all being washed into the reservoirs at an unprecedented rate.

By 1989, these problems could no longer be ignored. The United

States Congress that year amended the Safe Drinking Water Act, putting into motion a major review of the country's drinking water systems. New York City was faced with the potentially enormous cost of an artificial water filtration plant, estimated at as much as \$6–\$8 billion, plus yearly maintenance expenses amounting to \$300–\$500 million. That price tag meant potential catastrophe for New York's budget, and city officials were determined to avoid it. With vigorous lobbying, they won agreement from federal regulators to try the alternative of a watershed protection program capable of guaranteeing water quality indefinitely. Rather than pay for the costly new filtration plant, the city would spend the much smaller amount of about \$1.5 billion to protect the upstate watershed, including buying tracts of land as buffers and upgrading polluting sewage treatment plants. The EPA, in turn, would grant a five-year reprieve of its order, with the possibility of renewal.

The scheme was seriously challenged from the start. Powerful developers filed suit, claiming that property values would plummet as the city imposed restrictions on new construction. Environmentalists criticized the city's efforts as too weak. Nonetheless, the unprecedented agreement was a milestone in a world in which Nature's labor has too long been taken for granted. A major government body had acted as if an ecosystem—the watershed—were worth protecting in its natural state for the economic benefits it gives society. And it had invested in its restoration as if it were in fact a precious piece of infrastructure.

New York City planners had joined a new and diverse movement of prospectors for "green gold." Like the miners of yore, they were out to extract value from Nature and were in a rush to do so against competing forces. But rather than aiming pickaxes and dynamite at a nonliving, finite trove of gold, they wielded scientific studies and restoration projects, for the assets they sought were alive and renewable and would, if managed properly, continue to yield wealth for many years to come.

For most people who were paying attention, this came as a reve-

lation. Conservation could *save* money—a lot of money. Trees, for example, could be worth something more than timber, acquiring financial value for the gifts they give while standing and part of a healthy, functioning forest. Land could have financial value apart from its potential to have something mined from it or built or farmed on it. The labor of ecosystems previously regarded as "free" might even be quantified in some way, recorded on balance sheets, and formally considered in decision making.

Around the world, in city offices and university conference halls, among small groups of community activists and at the World Bank, scientists, legal scholars, bureaucrats, and professional environmentalists debated the implications of New York's experiment. Could it possibly work? Did scientists know enough about the mechanics of watersheds to give reliable advice on their management? And assuming the approach turned out to be justified, how widely could it be replicated?

In fact, without clear answers to these questions, and in many cases without knowing much about New York, governments around the world—in Curitiba, Brazil; in Quito, Ecuador; and in more than 140 U.S. municipalities, from Seattle, Washington, to Dade County, Florida—were starting to calculate the costs of conserving watersheds and compare them with the costs of building mechanical plants. In a bold departure from business as usual, they were taking stock of their natural capital. In the process, they were learning how ecosystems—environments of interacting plants, animals, and microbes, from coastal tide pools to Loire Valley vineyards to expanses of Amazonian rain forest—can be seen as capital assets, supplying human beings with a stream of services that sustain and enhance our lives. These "ecosystem services" provide not only food and wine but also cleansing of Earth's air and water, protection from the elements, and refreshment and serenity for human spirits.

As the saying goes, a woman's work is never done—nor fairly compensated—and this is nowhere truer than in the case of Mother Nature. Much of Nature's labor has enormous and obvious value, which has failed to win respect in the marketplace until recently.

Forests, for example, not only help purify water but also reduce potential harm from flooding, drought, and mudslides. They shelter people from winter storms and summer heat and provide homes for many of Earth's other living inhabitants. Most dramatically, they help stabilize climate by absorbing heat-trapping carbon dioxide (CO<sub>2</sub>) from the atmosphere.

Wetlands provide a similar range of valuable services. Along river floodplains, they slow and diminish the flow of water, protecting homes and roads from flood damage. In the process, they also purify the water. Along coastlines, wetlands and similar habitats nurture young fish, oysters, and other seafood. Coral reefs offer stunning beauty and recreational opportunities while supplying people with 10 percent of the fish consumed globally.

In farming regions, hedgerows and remaining native habitats support bees and other insects that pollinate crops. All told, the harvest of about one in three food crops worldwide—from alfalfa to watermelons—is possible thanks to the work of pollinators. And finally, all ecosystems foster genetic diversity, maintaining a "library" of genes with values yet to be discovered for future medical and industrial products.

Just as it makes human life possible, the work of ecosystems helps make life worth living. Forests, beaches, and wide-open spaces nourish our spirits and culture in ways we're only beginning to understand. Research suggests that communion with natural landscapes, plants, and animals can not only soothe and restore but even heal. In one study, for instance, hospital patients were randomly assigned to one of two types of room. Some looked out on a natural setting—a modest stand of trees—and others looked out at a building wall. The study, which controlled for health-related factors such as sex, weight, and tobacco use, showed that patients who looked out on a natural setting fared much better than did those with the view of a wall.

Historically, all these labors of Nature have been thought of as free. And with the exception of the production of a few specific goods, such as farm crops and timber, the use of Nature's services is actually quite startlingly unregulated. Despite our assiduous watch over other forms of capital—physical (homes, cars, factories), financial (cash, savings accounts, corporate stocks), and human (skills and knowledge)—we haven't even taken measure of the ecosystem capital stocks that produce these most vital of labors. We lack a formal system of appraising or monitoring the value of natural assets, and we have few means of insuring them against damage or loss.

Although governments have negotiated a wide array of global and regional agreements to protect certain ecosystems from degradation and extinction—such as the Ramsar Convention on Wetlands, the Convention on Biological Diversity, and the Convention on the Law of the Sea—these agreements are mostly weak, lacking the participation, resources, and systems of incentives and enforcement they need to be effective.

Even more striking is how rarely investments in ecosystem capital are rewarded economically. Typically, property owners are not compensated for the services the natural assets on their land provide to society. With rare exception, owners of coastal wetlands are not paid for the abundance of seafood the wetlands nurture, nor are owners of tropical forests compensated for that ecosystem's contribution to the pharmaceutical industry and climate stability. As a result, many crucial types of ecosystem capital are undergoing rapid degradation and depletion. Compounding the problem is that the importance of ecosystem services is often widely appreciated only upon their loss.

The source of this predicament is easy to comprehend. For most of humankind's experience on Earth, ecosystem capital was available in sufficient abundance, and human activities were sufficiently limited, that it was reasonable to think of ecosystem services as free. Yet today, Nature everywhere is under siege. Each year the world loses some 30 million acres of tropical forest, an area slightly larger than Pennsylvania. At this rate, the last rain-forest tree will bow out—dead on arrival at a sawmill or in a puff of smoke—around the middle of the twenty-first century. Biodiversity—short for biological diversity, the amazing variety of life on Earth—is being reduced to the lowest

levels in human history. Homo sapiens has already wiped out one-quarter of all bird species, and an estimated 11 percent more are on the path to extinction, along with 24 percent of mammal and 11 percent of plant species. One-quarter of the world's coral reefs have been destroyed, with many others undergoing serious decline. To top it off, we're taking fish out of the sea for consumption faster than they can reproduce. Dramatic as they are, these global statistics mask the accelerating loss of local populations of species—the individual trees that help keep water pure, the individual bees that pollinate our crops.

An overriding force behind this liquidation of ecosystem capital is the tremendous human demand for food and fiber—wheat, rice, cotton, timber, and so on. To produce these commodities, people already have dramatically transformed half of the planet's ice-free land surface, from natural landscapes to farmland, ranchland, and tree plantations. In many parts of the world, these activities are undermining the very resources that support them, depleting soil fertility and water supplies. Yet pressures are enormous to expand and intensify this production, despite its obvious toll.

The twenty-first century began with a growing sense among scientists that crucial thresholds had been reached and time to fix things was running out. We were operating beyond the limits of what Nature could sustain, conscious that we couldn't keep it up, but with no plan under way to change our course. As Stanford University biologist Peter Vitousek has said, "we're the first generation with tools to understand changes in the earth's system caused by human activity, and the last with the opportunity to influence the course of many of the changes now rapidly under way."

This increasingly apparent deadline has begun to inspire a shift in thinking for many scholars, most notably economists. To be sure, economists have long been concerned with issues of resource scarcity and limits to human activities. That's why their field was dubbed "the dismal science." Yet throughout the 1960s, 1970s, and 1980s, most economists clashed with ecologists. Economists accused