INTRODUCTION

Empathy for living things comes from many years of observing them in their natural environments, which is why field biologists have always been among the most adamant defenders of wild Nature.

REED F. NOSS, 1996

With surprisingly little debate and by unusually broad margins, in 1973 Congress approved one of the most sweeping environmental initiatives in American history: the Endangered Species Act.[1] The goal of this ambitious new law was to stem the rising tide of extinction that had swept away more than a thousand plants and animals since the beginning of the seventeenth century. According to the committee report accompanying the House version of the bill, countless organisms had "appeared, changed, and disappeared" during the more than four billion years since the earth had begun to support life. In recent decades, however, the pace of extinction had been "accelerating" at an alarming rate. The culprit in this unprecedented, tragic, and largely preventable biotic loss was humans: "As we homogenize the habitats in which these plants and animals evolved, and as we increase the pressure for products that they are in a position to supply . . . we threaten their—and our own—genetic heritage."[2]

Despite its comprehensive scope and strict prohibitions on harming species facing extinction, the Endangered Species Act attracted strong bipartisan support. The four versions of the bill introduced into Congress in early 1973 generated little discussion, even less controversy, and the Senate proposal breezed through in July by a unanimous 92–0 vote.[3] Two months later, after Rep. John Dingell reported that he had "yet to hear a whisper of opposition" to similar legislation he had introduced in the House, Dingell's bill passed by an equally impressive 390–12 margin.[4] In a statement issued after signing the new law on

December 28, 1973, President Nixon also declared unwavering support for the far-reaching measure.[5]

It is tempting to view the Endangered Species Act simply as a product of its times. The post–World War II period, particularly the late 1960s and 1970s, witnessed a remarkable environmental awakening in the United States and the West more broadly.[6] Higher levels of affluence, improved access to higher education, strong economic growth, continued technological development, growing media attention, and the diffusion of ecological concepts granted environmental issues unprecedented traction. Increasingly concerned not only about the myriad threats facing the natural world but also their potential impact on human health, Americans expressed their anxiety about the state of the environment in opinion polls, joined environmental groups in droves, and even took to the streets in protest. On April 22, 1970, more than 20 million participants celebrated the first Earth Day, a nationwide event billed as the "largest organized demonstration in human history."[7] Eager to appease their worried constituents, politicians responded with an outpouring of environmental legislation. Within the span of a decade, Congress passed the Wilderness Act (1964), the National Environmental Policy Act (1969), the Clean Air Act (1970), the Water Pollution Control Act (1972), the Marine Mammal Protection Act (1972), and no less than three versions of the Endangered Species Act (1966, 1969, and 1973). That expansive legal framework remains largely in place to this day.

While the Endangered Species Act undoubtedly rode the crest of the postwar environmental movement, it would be a mistake to see the measure solely as a consequence of that movement. History is characterized not only by change over time but also by continuity, and to properly understand the origins of this extraordinary legislation, it is important to recognize that the Endangered Species Act emerged from a long-standing dialogue about the issue of human-induced extinction. One logical starting point for exploring that extended discussion (and the one I have chosen for this book) is the eighteenth century, when a handful of commentators began to suspect that prehistoric humans might have wiped out some of the strange beasts whose fossil remains were being dug up at numerous locations around the world. The authors of these early speculations remained a distinct minority, however, for most educated Westerners at the time firmly rejected the idea that any kind of extinction—whether human-caused or otherwise—could take place. For them, the loss of any creature violated deeply held views about the overall stability and perfection of the natural world.

The meticulous, widely publicized studies of living and extinct elephants that the French naturalist Georges Cuvier completed at the end of the eighteenth and the beginning of nineteenth centuries erased all doubts about the possibil-

ity of extinction. Soon thereafter, a series of pioneering reports documenting the loss of more contemporary island fauna—like the dodo, the moa, and the auk—offered additional evidence supporting the reality of extinction. Later in the nineteenth century, the precipitous decline of the bison, the passenger pigeon, and other once abundant species proved beyond a shadow of doubt that humans could even wipe out organisms with vast continent-wide distributions. Yet, as the power of humanity to extirpate plants and animals became increasingly apparent, so did efforts to rescue declining species from the fate of oblivion.

Naturalists—individuals who pursued natural history either as hobby or a profession—not only proved central to the discovery of extinction but were also among the earliest groups to condemn the careless destruction of plants and wildlife going on around them. Although it has deep roots in Western society, the practice of natural history has experienced significant changes over the ages.[8] The thirty-seven books of Pliny the Elder's *Natural History* (ca. AD 77), which touched on a dizzying array of topics ranging from anthropology to zoology, illustrate the once expansive breadth of the enterprise. During the early modern period, Pliny's successors gradually narrowed the scope of natural history to encompass nonhuman natural objects—principally, animals, plants, and minerals—as well as natural phenomena such as the weather and tides. Accompanying this restriction in scope was a shift from highly stylized to more naturalistic illustrations and a corresponding elimination of the folklore, fables, astrological references, religious symbolism, and imaginary creatures that had once graced the pages of bestiaries, herbals, and other early natural history publications.

Between the sixteenth and the nineteenth centuries, a more popular interest in natural history also took root and blossomed. First in Europe and later in America, the well-to-do began cultivating the practice by subscribing to lavishly illustrated publications, amassing cabinets of curiosity, planting pleasure gardens, stocking menageries, and sponsoring collectors who journeyed to the far corners of the earth. The first natural history museums and botanical gardens, established in Renaissance Europe, expanded greatly in size and number following the discovery of the New World.[9] In a practice that would later be dubbed "bioprospecting," governments, corporations, and wealthy individuals scrambled to exploit the commercial potential of exotic biota discovered during overseas explorations.[10] And natural history enthusiasts of all stripes banded together to form clubs that organized field trips, established museums, and issued publications.[11] An aesthetic interest in nature, a conviction that the natural world offered a window onto the mind of God, a belief in the didactic value of nature study, and a desire to exploit the commercial potential of natural resources undergirded the continued expansion of popular interest in natural history.

During the eighteenth and nineteenth centuries, natural history not only became increasingly fashionable, but its structure and practice also transformed in two fundamental ways.[12] First, it gradually splintered into a series of more specialized disciplines, each with its own particular subject matter, agenda, and techniques. This process of discipline formation began with botany, zoology, and geology, which, in turn, spawned even more specialized fields. Individuals who focused on the study of birds, insects, and mosses became known as ornithologists, entomologists, and bryologists, to cite just a few of the many emerging specialties. By the second half of the nineteenth century, practitioners in these new fields began organizing their own scientific societies, publishing in narrowly focused technical journals, and issuing esoteric monographs.[13] A few of the luckier ones also secured professional positions related to their area of expertise, working for museums, governmental agencies, and universities at a time when such employment opportunities remained exceedingly rare.

Second, and closely related to this first transformation, the practitioners in these emerging specialities increasingly focused on taxonomy, the naming, description, and classification of living organisms. At one time, naturalists considered virtually any nugget of information about a species as not only valuable but also relevant to their studies. During the late eighteenth and the nineteenth centuries, however, they increasingly honed in on the external morphology—that is, the form, shape, and size—of organisms, while largely ignoring their life history, behavior, and relationship with their environment. This narrowing gaze coincided with a narrowing research agenda. The central organizing pursuit for most natural history fields became the creation of an exhaustive, authoritative, and rationally ordered inventory of the particular group on which they specialized. In *Systema naturae* (1735), one starting point for modern biological taxonomy, the Swedish botanist Carl Linnaeus declared that "classification and name-giving will be the foundation of our science."[14] But where Linnaeus remained a generalist who sought to construct systems of classification and nomenclature that were not only broadly applicable to all flora and fauna but also relatively easy for novices to use, his successors produced increasingly unwieldy classification schemes as well as publications that were narrow, technical, and generally inaccessible.

The twentieth century presented both opportunities and threats to the natural history tradition. Popular natural history continued to experience robust growth. Books, magazines, films, museums, zoos, (and later) television featured widely accessible examples of nature's diversity that could simultaneously entertain and educate the public while cultivating a sense of connection with the natural world.[15] At the same time, more and more Americans regularly pursued outdoor recreation opportunities that offered firsthand contact with nature. Birdwatch-

a signal that it faced imminent danger of extinction. Methodical examination of published local lists of organisms, long a favorite genre in natural history, offered additional clues about changes in the population status and range of species.

As naturalists struggled to catalog the earth's biodiversity, they encountered numerous organisms that seemed to be either teetering on the brink of extinction or lost entirely. Until the middle of the nineteenth century, they tended to respond to this discovery with some degree of resignation. After all, the fossil record revealed myriad species that had been lost to extinction in the past, a fate that naturalists attributed to a variety of causes: climate change, natural disasters, disease, competition, and species senescence (the belief that species eventually died out, just as individuals did). The contemporary declines that they were witnessing were not really that much different from these earlier extinctions, they initially surmised, even if humans now seemed responsible. But as examples of human-caused extinction multiplied in the second half of the nineteenth century, naturalists grew increasingly haunted by the specter of extinction.

They acted on that deepening concern in a variety of ways. On the most basic level, they publicized examples of past extinctions while expressing alarm about impending losses. This is exactly what a young curator at Harvard's Museum of Comparative Zoology, the mammalogist and ornithologist Joel A. Allen, did in a pioneering set of articles published in 1876. While many Americans were celebrating the economic and material progress their nation had enjoyed in the century since its founding, Allen lamented a by-product of that progress: the imminent passing of the bison. He also decried the decline or loss of numerous other North American birds and mammals since Europeans first set foot in New World. In essence, what Allen did was extend the methods and practices of natural history to lost and vanishing species. But rather than fashion a catalog of existing species, as he and his colleagues had traditionally done, he documented their decline. Through fieldwork, the examination of museum specimens, and the scrutiny of published accounts of naturalists, explorers, and travelers, he crafted one of the first (albeit limited) inventories of endangered species. Over the next century, such inventories would not only become increasingly common but also more comprehensive before culminating in the official lists that International Union for the Conservation of Nature began maintaining in 1963 and the U.S. Fish and Wildlife Service's Committee on Rare and Endangered Wildlife Species initiated a year later.

But why should anyone care if the vanishing species recorded in these inventories were to be lost? To answer this most basic question, naturalists developed and deployed seven basic arguments for species preservation during the two centuries leading up to the Endangered Species Act of 1973. First was the

aesthetic beauty of plants and animals. The gradual diffusion of romanticism in the eighteenth and nineteenth centuries promoted thinking about the natural world in deeply aesthetic terms.[23] Writing in his journal in 1856, for example, the American author, transcendentalist, and naturalist Henry David Thoreau lamented the fact that many of the "nobler animals" had been exterminated in the area surrounding Concord. He then compared the biologically impoverished countryside surrounding his home to a vandalized book of poetry: "I take infinite pains to know all the phenomenon of spring . . . thinking that I have here the entire poem, and then, to my chagrin, I hear that it is but an imperfect copy that I possess and have read, that my ancestors have torn out many of the finest leaves and grandest passages, and mutilated its page."[24] Fifty years later, William Beebe, the colorful deep-sea explorer and curator of birds at the New York Zoological Society, used a similar metaphor when he linked living organisms with great works of fine art. If an example of the latter were destroyed, it might be reconstructed, but "when the last individual of a race of living beings breathes no more, another heaven and another earth must pass before such a one can be again."[25]

The second argument for preserving endangered species involved more crassly utilitarian concerns: plants and animals provide a variety of useful and economically valuable resources, such as food, drugs, leather, fiber, and oils. On one level, this argument simply stated the obvious. Since first landing on American shores, Europeans had tended to view the New World as a vast storehouse of "merchantable commodities," a view that became both pervasive and deeply engrained.[26] Indeed, by the end of the nineteenth century, commercial exploitation of wildlife was so extensive that it posed increasingly obvious threats to numerous species. In *Our Vanishing Wildlife* (1913), for example, the outspoken naturalist, conservationist, and zoo administrator William Temple Hornaday cautioned that the fate of the once ubiquitous passenger pigeon offered a sobering lesson about the consequences of unrestrained wildlife commodification: "Any wild bird or mammal species can be exterminated by commercial interests in twenty years time, or less."[27] A decade earlier, the botanist and paleontologist Frank Hall Knowlton made a similar point we he warned that if the monetary value of rare plants were publicized as part of a campaign to save them, unscrupulous dealers and collectors would eagerly descend upon them and "their doom would be fixed."[28] So when early conservationists spoke of the value of plants and wildlife, they often framed their discussion in terms of the *services* rather than the *products* that those species provided. One example they often invoked involved songbirds, which supposedly boosted agricultural production by destroying pest insects, weeds, and rodents.[29]

After securing a series of state and federal laws that severely restricted commercial exploitation of most native game species, conservationists felt more comfortable touting the potentially marketable products that wild species provided. While writing in support of nature protection in Latin America on the eve of America's involvement in World War II, for example, the American mammalogist and international conservationist Harold J. Coolidge asserted unapologetically that wild flora and fauna represented "an immeasurable capital, a capital that ought not to be ruthlessly spent, but rather stewarded with care."[30] By the second half of the twentieth century, economic arguments loomed increasingly large in support of endangered species preservation.[31]

Yet, according to the twentieth-century naturalist and wildlife manager Aldo Leopold, relying on an economic justification for species preservation proved problematic because "most members of the land community have no economic value."[32] Each and every organism, however, does play a crucial role in maintaining the stability of the natural world, naturalists asserted in the third argument for species preservation. As early as the mid-eighteenth century, Linnaeus began developing protoecological arguments about the interrelationships between individual organisms within a given biological community. By the early twentieth century, the emerging science of ecology more deeply illuminated the complex, multifaceted connections within what would become known as "ecosystems" by the post–World War II period. In a series of publications issued in the middle of that century, Leopold warned that wildlife management not only needed to become more ecologically informed but also to make species preservation its top priority. After all, he argued, "To keep every cog and wheel is the first precaution of intelligent tinkering."[33]

Complementing the ecological argument for species preservation was the evolutionary argument, the fourth justification for attempting to prevent extinction. The plants and animals that surround us are of "great antiquity," the paleontologist, museum administrator, and Columbia University professor Henry Fairfield Osborn pointed out repeatedly at the dawn of the twentieth century.[34] Rapidly diminishing creatures like the bison, deer, wapiti, and pronghorn antelope "were not made in a day, nor in a thousand years, nor in a million years." Rather, they gradually emerged from the "ceaseless trials of nature," over vast eons of time. Naturalists understood and appropriately respected the fact that every extant organism serves as a "living monument of adaptation and beauty, which connects the past with the present," while the public already cherished ancient *cultural* monuments, like the Parthenon and Westminster Abbey. Now it was time for scientists to cultivate a broader "veneration of age sentiment" for living creatures too, before they were lost to extinction.

In addition to being the products of evolutionary change over vast spans of time, naturalists argued, native plants and animals also played a central role in shaping American identity. During the late eighteenth and early nineteenth centuries, refined North Americans embraced the notion that much of their distinctiveness as a people stemmed from the abundant natural world that surrounded them. The New World might lack the cultural achievements of the Old, but it did possess unique, wild features that were largely absent in long-settled Europe. Following independence, a fervent nationalism not only became a key motivation for studying natural history in the United States but also informed early calls for nature preservation.[35] As industrialization and urbanization increasingly took hold in the second half of the nineteenth century, commentators worried openly not only about the prospects of America's wild heritage but also about the plight of its citizens who would be denied access to that rapidly vanishing legacy.

The pursuit of science offered a sixth rationale for protecting vanishing species and their habitats. In the 1840s, the British naturalist Hugh Strickland warned that civilization's inexorable march forced the disappearance of numerous organisms across the globe. One result, he argued, was that "the Zoologist or Botanist of future ages will have a much narrower field for his researches than that which we enjoy at present."[36] Strickland urged his fellow naturalists to redouble their efforts to catalog the earth's flora and fauna before it fell victim to human-initiated destruction. Over the next century, however, his successors refashioned the looming threat of biological extinction into a call for nature preservation to ensure future opportunities for the scientific study of living organisms in the field. Writing in the early 1920s, for example, the American naturalist Francis B. Sumner called on his colleagues to rescue "a few fragments of vanishing nature" to guarantee the possibility of future field studies.[37] Here Sumner had in mind not only the perpetuation of the individual species essential to the pursuit of taxonomically focused natural history, but also of assemblages of organisms indispensable to the emerging field of ecology. One of Sumner's colleagues, Charles C. Adams, argued that it was vital for ecologists to have continued access to relatively undisturbed natural areas to provide what he called a "bionomic baseline" for ecological study, an argument that would be raised repeatedly over the ensuing decades.[38]

Naturalists also developed explicitly ethical arguments for species preservation. Near the end of his famous thousand-mile walk from Wisconsin to the Gulf of Mexico in 1867, the American nature writer and amateur geologist John Muir chided humanity for failing to show appropriate regard for fearsome beasts like the alligator: "How narrow we selfish, conceited creatures are in our sympathies! How blind to the rights of the rest of creation!"[39] This was not the first

time anyone had suggested the possibility of extending the notion of rights to nonhuman beings; indeed, humanitarians had begun making similar arguments for domesticated species as early as the late eighteenth century. But according to the historian Roderick Nash, Muir's insight represented the first "association of rights" with the natural world more broadly and wildlife specifically.[40] Nearly a century later, Leopold drew extensively from the science of ecology to develop his notion of "the land ethic." Leopold's bold new vision called for an individual to begin viewing him- or herself as a "plain member and citizen" of the land community rather than "conqueror" of it, as modern humans had typically done. That ethical stance, in turn, implied "respect for his fellow-members, and also respect for the community as such."[41] It also supported the idea that all species have a "biotic right" to exist.[42] What Muir, Leopold, and their later colleagues were stumbling toward here was a notion of the intrinsic value of species, a value independent of human needs and concerns.

Naturalists also developed a second set of ethical arguments involving a notion of responsibility to future human generations. Heedlessly destroying wild species rendered them permanently unavailable to fulfill the many roles they had traditionally played both in nature and human society. Or as Hornaday put it, Americans had a solemn duty to ensure that future citizens would continue to enjoy the many values associated with wildlife: "The wild things of this earth are *not* ours, to do with as we please. They have been given to us *in trust*, and we must account for them to the generations which will come after us and audit our accounts."[43]

Beyond the aesthetic, economic, ecological, evolutionary, cultural, scientific, and ethical arguments they articulated to the public, naturalists were also motivated to act on behalf of endangered species from their emotional attachment to and identification with many of those species. Indeed, those links, typically forged during youthful forays into natural history, often played a decisive role in their decision to take up formal study of those species in the first place.[44] As the ornithologist Frank M. Chapman once claimed, birds "have not only a beauty which appeals to the eye, but often a voice whose message stirs emotions to be reached only through the ear. . . . They further possess humanlike attributes which go deeper still, arousing in us feelings which are akin to those we entertain toward our fellow-beings."[45] Chapman, who was more explicit than most of his colleagues in discussing the emotional bond he and other naturalists forged with wild creatures, even entitled his 1933 memoirs *Autobiography of a Bird-Lover.* Six decades later, the founder of conservation biology Michael Soulé declared that "most biologists *love* plants or animals—they love different ones. Some like lizards, some like grasses. But there's a certain affinity we have and even identifi-

cation we have with the objects of our study. So it's hard for me to imagine why a person would not want to protect the diversity of those entities in the group he or she is interested in."[46]

Recognizing that generating publicity and cogent arguments alone would not save rapidly declining species, naturalists pursued a variety of other strategies as well. Beginning in the 1880s, they not only established conservation committees within newly emerging scientific societies but also wildlife protection organizations open to members of the public. Chapman, for example, played a key leadership role in the Audubon bird protection movement, which, from the end of the nineteenth century, relied on the tripartite strategy of education, legislation, and enforcement to snatch numerous threatened birds from the jaws of extinction. He also began publication of *Bird-Lore*, a popular journal of ornithology that served as the official organ of state Audubon Societies and (later) the National Association of Audubon Societies, established in 1905.

Other naturalists used their scientific know-how and political savvy to benefit endangered wildlife more directly. Working under the auspices of the New York Zoological Society and the American Bison Society, William Temple Hornaday undertook captive breeding experiments with the American bison, and he used the resulting progeny to restock newly established federal wildlife reserves in the West. Soon, captive breeding joined public education, protective legislation, habitat manipulation, predator control, and refuge creation as standard techniques in the wildlife conservationists' toolbox. Hornaday and later naturalists also successfully lobbied for a long series of wildlife protection laws and treaties that culminated in the Endangered Species Act of 1973, the first law of its kind anywhere in the world.

That is not to suggest that all naturalists firmly embraced the idea of political engagement with the issue of extinction. In 1902, when the American ornithologist Charles Cory was being recruited to join a local Audubon Society, as many of his colleagues had already done, he reportedly responded: "I don't protect birds. I kill them!"[47] Cory's reply may have been offered tongue-in-cheek, but many of the naturalists so busily engaged in cataloging the earth's biota openly challenged efforts to restrict their collecting activities. They resisted not only by vocally defending their right to collect but also by consistently (and probably justifiably) arguing that, relative to other threats, their activities resulted in little overall impact on most plant and animal populations. They also offered more active resistance, by continuing to seek out rare and vanishing species, even in defiance of local, state, and federal law. For well into the twentieth century, for example, long after the range of the once abundant heath hen had been reduced to a single island off the coast of Massachusetts and serious concerns about the

species' future had begun to be broadly voiced, America's preeminent ornithologist, William Brewster, continued to pursue multiple specimens of the prized rare bird for his extensive personal collection. He did so while serving as president of the Massachusetts Audubon Society, an early, particularly active bird protection organization. Even the stalwart Frank Chapman collected multiple specimens of the critically endangered Carolina parakeet during expeditions to Florida in the 1890s and 1900s.[48] Taken as whole, though, the remarkable thing about naturalists' growing involvement with the issue of wildlife extinction is not that it provoked tensions, contradictions, and occasional opposition, but that the level of engagement was so prolonged and so deep.

While my focus is on extinction-related ideas, policies, and institutions promoted by American naturalists, I have also tried to show how they participated in a longstanding (though sometimes tenuous) transnational conversation.[49] European naturalists loom particularly large in the first two chapters, which explore the discovery of extinction and its wide acceptance as a recurring phenomenon by the first half of the nineteenth century, but they also make occasional appearances at other suitable points in the narrative. My decision to concentrate on the ideas and practices of American naturalists is based on several considerations: the fact that U.S. initiatives often played a formative role on the world conservation stage (e.g., the establishment of national parks and the passage of the Endangered Species Act of 1973), the broad chronological sweep of this study, a related need to reign in an already unwieldy narrative, and my own particular interests and expertise.[50]

Similarly, I have restricted this account almost exclusively to concern about wildlife extinction. Following on the heels of the successful Audubon movement that began at the end of the nineteenth century, a handful of American botanists began publicly expressing alarm about the fate of the nation's flora. Worried about the commercial exploitation of rare plants, the growing army of outdoor recreation enthusiasts who stripped the landscape of its wildflowers, and the continued habitat destruction that accompanied the nation's ongoing economic expansion, in 1900, flora enthusiasts in the Boston area organized the Society for the Protection of Native Plants. Two years later, the American botanist Elizabeth N. Britton helped found a competing institution, the Wild Flower Preservation Society, based out of the New York Botanical Garden. By the late 1920s, these and similar organizations successfully lobbied for legislation to protect at least some plants in more than twenty-two states, though that conservation legislation generally covered only a few species and was rarely enforced.

Compared to their colleagues struggling to rescue endangered wildlife, however, plant protectionists faced several distinct obstacles. Most fundamental was

a common law tradition that considered wild animals as ferae naturae, a public good and the property of no one until captured or killed.[51] Related to this long-standing doctrine was the presumed right of the government to regulate the taking of game, a right first asserted in feudal Europe. In a landmark case handed down in 1896, *Geer v. Connecticut*, the U.S. Supreme Court affirmed that states were entitled to "control and regulate the common property in game," and they were to do so as "a trust for the benefit of the people." Plants, on the other hand, possessed an entirely different legal status. Rather than being considered public property, and hence subject to governmental regulation, vegetation was generally thought to be the property of whoever owned the land on which it grew.[52]

Compounding this basic legal difficulty, rare plants were also much more difficult both to bond and identify with. While many of them clearly possessed appealing aesthetic characteristics, they were less amenable to being conceptualized in human terms than animals, particularly birds and mammals that formed lasting pair bonds, reared their young, and openly communicated with one another.[53] For these and other reasons, by the time the Endangered Species Act gained passage in 1973, the scope and scale of plant conservation in the United States proved negligible compared to efforts to save endangered wildlife.[54]

THE BASIC ARGUMENT that runs through this book then is straightforward: naturalists' interest in collecting, describing, and classifying the earth's organisms alerted them to the growing problem of human-caused loss of plants and animals while fostering sympathy for their desperate plight. Increasingly haunted by specter of extinction, naturalists mobilized to act. They publicized the decline of wildlife in technical and popular publications, formulated arguments for their preservation, established conservation organizations, developed techniques for studying and saving rare species, and lobbied for protective reserves and legislation. This is by no means the first book to recognize the central role that naturalists have played in American wildlife conservation, but it is the first to provide a long view on their sustained and substantial efforts to discover, problematize, and respond to the issue of extinction over a roughly two-century period leading up to the Endangered Species Act of 1973. Without their ongoing campaign to rescue vanishing species, the natural world would undoubtedly be facing an even more bleak and biologically impoverished future.

CHAPTER ONE

BONES OF CONTENTION

THE AMERICAN INCOGNITUM AND THE DISCOVERY OF EXTINCTION

Such is the æconomy of nature, that no instance can be produced of her having permitted any one race of her animals to become extinct; or her having formed any link in her great work so weak as to be broken.

THOMAS JEFFERSON, 1784

JEFFERSON'S DILEMMA

At the height of the American Revolution, while the outcome of the rebellion against Great Britain remained uncertain, Thomas Jefferson grappled with the problem of fossils. The specific context of his engagement with this thorny issue was a manuscript that he began sometime in the summer or early autumn of 1780. At the time the thirty-seven-year-old governor of Virginia and author of the Declaration of Independence already enjoyed a considerable reputation for accomplishment in the political sphere. Less well known to his contemporaries was his keen interest in science. Jefferson was an inveterate reader of scientific treatises, a zealous recorder of natural phenomena, and an eager correspondent with others who shared his enthusiasm. He would later reflect on his longstanding curiosity about the natural world by declaring that "Science is my passion, politics my duty."[1]

In 1780, when the secretary to the French minister in Philadelphia, François Marbois, circulated a detailed questionnaire regarding the political and natural history of Virginia, Jefferson seized the opportunity to organize his abundant notes. Faced with a long series of personal and political crises—including the

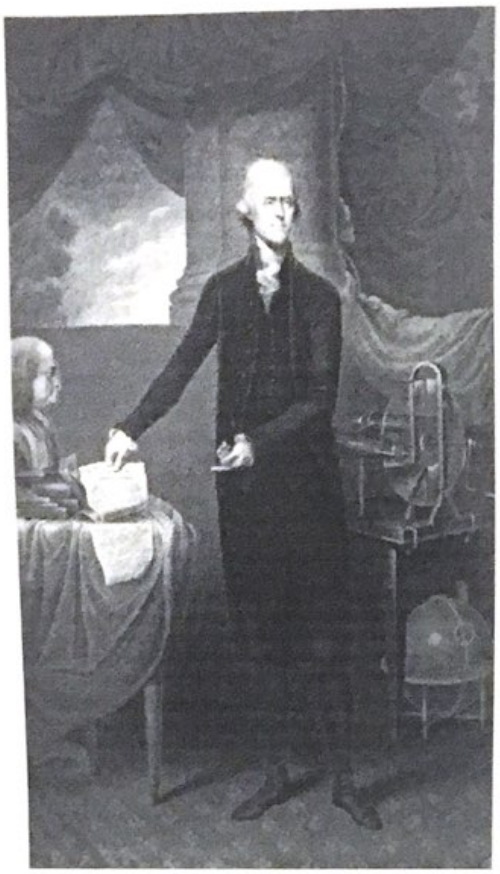

FIGURE 1. Jefferson with Declaration of Independence and scientific instruments, 1801. Engraving by Cornelius Tiebout. In addition to his considerable accomplishment in the political sphere, Jefferson was also a skilled naturalist who made early, important contributions to the field of paleontology. Courtesy of the Prints and Photographs Division, Library of Congress, LC-USZ62-75384.

death of his daughter, the prolonged illness of his wife, a nasty injury sustained in a fall from his horse, forced retreat first from the state capital in Richmond and then from his estate in Monticello, and accusations that he had engaged in dishonorable conduct during the period of British occupation—Jefferson endured some of the darkest days of his entire life. Yet, at Poplar Forest, his beloved rural retreat nestled in the Blue Ridge Mountains, he found solace in the hours devoted to fulfilling Marbois's request. By the time he returned to Monticello in August 1781, he was nearly finished drafting the manuscript. The resulting publication, issued three years later as *Notes on the State of Virginia*, proved the only book Jefferson would publish during his lifetime. It is now widely considered a classic, "one of America's first permanent literary and intellectual landmarks."[2]

Although he had long been fascinated with science, *Notes on the State of Virginia* signaled the beginning of Jefferson's active interest in fossil vertebrates.[3] Interspersed among his discussion of political philosophy, his ideas about religious freedom, and his famous condemnation of slavery, Jefferson meticulously cataloged the natural resources of his home state and the surrounding region. The first animal he described was also the one to which he devoted the most

attention: "the Mammoth, or big buffalo," a creature he judged to be "six times the size of an elephant," which it seemed to resemble.[4] What little was known about this "incognitum" (as it was often referred to at the time) came from tales about the beast that Indians had passed down through the generations and from fossilized remains that had been uncovered in America beginning in the early eighteenth century. Since that initial discovery, the creature's teeth and bones had become highly sought after additions to institutional museums and private cabinets of curiosity on both sides of the Atlantic. In America, for example, not only Jefferson, but also George Washington and Benjamin Franklin owned prized specimens of the grinders from these mysterious beasts.[5]

For Jefferson, the incognitum proved not only an intrinsically fascinating creature, it also provided ammunition in an ongoing campaign to refute the theory of one of Europe's most renowned naturalist during the second half of the eighteenth century, Georges Louise Leclerc, Comte de Buffon, who was Intendant of the Jardin des Plantes and Keeper of the Royal Cabinet of Natural History in Paris. In his best-selling, thirty-six-volume *Histoire naturelle, générale et particulière* (1749–89), Buffon argued that the New World's generally cool and moist environment had forced its native inhabitants to degenerate over time, rendering them punier, less vigorous, and less fertile than their Old World counterparts.[6] Stung by the assault on his homeland and its people, Jefferson felt compelled to respond. In a discussion with explicitly nationalistic overtones, he asserted the morality, fecundity, and intelligence of America's aboriginal inhabitants. He also produced two tables showing that the mammals native to the land of his birth fared quite well when their weight or overall numbers were compared with those in Europe. The bones of the mysterious "incognitum," the "largest of all terrestrial beings," however, offered Jefferson with the strongest potential evidence in his bid to refute Buffon's troubling theory.[7] The problem was Jefferson could not prove that the prodigious beast still roamed the earth.

For the remainder of his life, Jefferson vigorously pursued the American incognitum and other quadrupeds whose fossilized remains were periodically uncovered across North America. He not only personally financed numerous expeditions to retrieve fossil remains but also encouraged others to follow his lead. For example, on December 19, 1781, the day before he sent his completed Virginia manuscript to the French consul in Philadelphia, Jefferson wrote to General George Rogers Clark, an old friend, Albemarle County native, and the commanding officer of the Army of the West. Jefferson's note, delivered by none other than Daniel Boone, asked Clark to venture to Big Bone Lick, Kentucky, on the banks of the Ohio River, to retrieve bones of the American incognitum. The threat of Indian attack kept Clark away from the area, so a year

later Jefferson repeated his request, declaring: "A specimen of each of the several species of bones now to be found is to be the most desirable object in Natural History, and there is no expense of package or safe transportation which I will not gladly reimburse to procure them safely."[8] Despite his strict constructionist principles, as president of the United States Jefferson provided federal support so the Philadelphia artist, naturalist, and museum owner Charles Willson Peale could unearth a complete skeleton of the incognitum from a soggy marl pit along the Hudson River. With the bones he found, Peale mounted and displayed one of the earliest virtually intact fossil skeletons ever to be reconstructed, an outcome that thrilled Jefferson.

Jefferson enjoyed collecting fossil vertebrates—and proudly displayed them at Monticello—but he was also quite interested in furthering scientific understanding of these mysterious creatures. In keeping with that goal, he freely placed prized specimens in the hands of museums at home and abroad. The bones of the American incognitum that he sent to the prestigious National Museum of Natural History in Paris, for example, proved useful to French naturalists working in the nascent fields of paleontology and comparative anatomy.[9] He even published a paper of his own describing a new species of large fossil mammal, which he dubbed the megalonyx, based on bones recovered by workers digging saltpeter from a cave in Greenbrier County, Virginia (now West Virginia).[10] Although he thought the megalonyx was a fearsome gigantic clawed beast that dwarfed the African lion, thereby providing additional evidence against Buffon's theory of degeneracy, it later turned out to be a massive sloth that still bears his name, *Megalonyx jeffersoni*.

Although it strikes the modern reader as rather odd, Jefferson also firmly believed these creatures still survived somewhere in the unexplored regions of the continent. In his table of American and European mammals found in *Notes on the State of Virginia*, Jefferson listed the mammoth first. In defense of this decision he wrote: "It may be asked, why I insert the Mammoth as if it still existed? It may be asked in return, why I should omit it, as if it did not exist? Such is the œconomy of nature, that no instance can be produced of her having permitted any one race of her animals to become extinct; of her having formed any link in her great work so weak as to be broken."[11] Beyond this basic philosophical objection to extinction was the "traditionary testimony of the Indians, that this animal still existed in the northern and western parts of America," regions that remained "in their aboriginal state, unexplored and undisturbed."[12]

To Jefferson and many of his contemporaries, the very idea of species extinction seemed anathema. Intellectuals of his day recognized that settlement often resulted in the local extermination of wildlife. But the complete disappearance

of a species was another matter altogether. The loss of any organism across its entire range implied an unacceptable imperfection in God's creation, while violating deep-seated assumptions about the balance of nature and the great chain of being that proved central to Western understandings of how that creation was ordered. In the hope that living examples of these beasts might still be found wandering somewhere in the unexplored regions of North America, Jefferson urged the explorers Meriwether Lewis and William Clark to keep a sharp lookout out for species animals "deemed to be rare or extinct," like the American incognitum, during their famous western exploring expedition. The Corps of Discovery found a host of new plant and animal species during their arduous two-year journey, but they encountered no lumbering elephants.[13]

While Jefferson's doubts about the possibility of extinction remained commonplace at the time he penned *Notes on the State of Virginia*, by the time of his death in 1826, most naturalists on both sides of the Atlantic had experienced a sea change in their ideas on the subject. Central to this transformation was the work of the brash young French naturalist, Georges Cuvier. With access to specimens provided by a transatlantic fossil network and training from prominent German anatomists, Cuvier deployed the principles of comparative anatomy to offer convincing evidence that extinction had been a regular part of the earth's history. Cuvier was the first naturalist to clearly distinguished between the two living species of elephant and two kinds of extinct fossil elephant, the mammoth and the mastodon, the latter of which he clearly differentiated and named in 1806. During the first several decades of the nineteenth century, he went on to describe a virtual zoo of lost creatures, thereby laying the foundations for modern paleontology. Within a surprisingly short period of time, the reality of extinction became central to most educated Westerners' understanding of the earth's history. Later in life, even Jefferson himself privately admitted that some species might have been lost.[14] Yet, as we shall see later, some of the ideas that had led him and most other naturalists to deny the reality of extinction—for example, the notion of plentitude that proved central to the great chain of being and the idea that nature was finely balanced—remained important to thinking about the natural world long after the possibility of extinction became widely accepted.

PROVIDENTIAL NATURAL HISTORY AND THE ORDER OF NATURE

Jefferson and most of his contemporaries were certain that the natural world was orderly, static, and new. Most importantly, and one of the beliefs undergirding these convictions, they also firmly believed that it was the product of a divine

mind.[15] One way to understand that mind, and at the same time to ensure that science and religion, reason and faith remained firmly reconciled, was a set of practices and beliefs known as natural theology.[16] As with so many foundational concepts in the Western world, the basic idea of natural theology—that careful scrutiny of the natural world revealed attributes of its creator—dates back to the ancient Greeks. During the Middle Ages, Aquinas and the scholastics labored to show how reason melded harmoniously with faith to demonstrate the existence and attributes of a Christian god. At end of the seventeenth and the beginning of the eighteenth centuries, these ideas found full expression when the famed British naturalist John Ray published *Wisdom of God Manifested in the Works of the Creation* (1691). Ray's influential, widely reprinted book combined observations and specific arguments made by previous authors with his own considerable knowledge of flora, fauna, and systematics.[17]

Ray leaned heavily on a line of reasoning central to the natural theology of his day: the argument from design.[18] This argument held that since the obvious order and complexity of the world could not have possibly emerged from nature itself, an intelligent designer must have imposed it. Just as human-made buildings and machines "do necessarily infer the being and operation of some intelligent Architect or Engineer," Ray argued, "why shall not also the Works of Nature, that Grandeur and Magnificence, that excellent contrivance for Beauty, Order, Use, &c., which is observable in them, wherein they do as much transcend the Effects of human Art as infinite Power and Wisdom exceeds finite, infer the existence of an Omnipotent and All-wise Creator?" Proponents of the argument from design applied it on multiple scales, ranging from individual organs (like the eye or the human hand) to particular species (like the honey bee or the beaver) to the larger patterns of relationship between species (e.g., the adaptations of prey to escape predation). In all cases, though, structure seemed to be perfectly adapted to function, while the order and complexity of nature was thought to reveal the wisdom, power, and beneficence of God.

When it came to conceptualizing the specific patterns of relationship between species, however, many possibilities presented themselves. One deeply entrenched way of thinking about that order was the chain of being or *scala naturae*, the idea that the diversity of the natural world could best be understood as a long chain containing every possible kind of organism in a linear, continuous series.[19] In its most expansive form, the great chain of being was thought to encompass not just living organisms, but all kinds of being from "nothing to the Deity."[20] The idea has its roots in the Platonic view that the world is full and all possible kinds of things exist (the notion of plentitude) and the Aristotelian belief

that all creatures could be lined up in a hierarchical series, with no gaps between them (the notions of continuity and gradation).

Well into the eighteenth century, naturalists struggled to reconcile the expanding, increasingly detailed observations of known organisms into a single, hierarchical, continuous series. The idea of the chain of being proved central, for example, to the renowned Swedish naturalist Carl Linnaeus, who not only introduced the binomial system of scientific nomenclature but also developed widely adopted systems of botanical and zoological classification.[21] Linnaeus once wrote that "the closer we get to know the creatures around us, the clearer is the understanding we obtain of the chain of nature, and its harmony and system, according to which all things appear to have been created."[22] Similarly, in the preliminary discourse to his *Histoire naturelle,* Buffon argued that if man placed himself at the "head of all created beings, he would see with astonishment that one could descend by almost imperceptible degrees from the most perfect creature to the most shapeless matter, from the most organized animal to the crudest mineral; he would recognize that these imperceptible nuances were the greatest work of Nature."[23] Nor was the idea of the great chain of being confined to biological circles; rather, it remained the common cultural heritage of most educated Europeans and Americans until the end of the eighteenth century.[24]

The pervasive idea of the great chain of being had strong implications for how the notion of extinction was received. For if God had created every conceivable form and no discernable gaps existed between them, then the loss of any creature threatened to bring down the entire edifice. The British poet Alexander Pope simultaneously celebrated the chain of being while expressing concern about the implication of extinction in his *Essay on Man* (1733–34):

> Vast Chain of Being! which from God began,
> Natures aetherial, human, angel, man,
> Beast, bird, fish, insect, what no eye can see,
> No glass can reach; from Infinite to thee,
> From thee to nothing.—On superior pow'rs
> Were we to press, inferior might on ours:
> Or in the full creation leave a void,
> Where, one step broken, the great scale's destroyed:
> From Nature's chain whatever link you strike,
> Tenth or ten thousandth, breaks the chain alike.[25]

The great chain of being offered one widely adopted model for thinking about the apparent order of the world; the notion that nature was balanced provided a

different (though complimentary) way of conceptualizing that order.[26] Not surprisingly, the idea that nature exists in some kind of overall balance also has deep roots in antiquity. Indeed, as the historian of ecology Frank Egerton has argued, "In one way or another a balance-of-nature concept is part of most cosmologies."[27] Early discussions of the idea tended to be vague and general, but by the end of the seventeenth and the beginning of the eighteenth centuries, naturalists like Ray began to marshal specific biological evidence—like the existence of finely tuned predator-prey relationships—to show how God ensured nature's balance.

Perhaps not surprisingly, the inveterate namer and classifier Linnaeus first provided a title for the balance-of-nature concept, while at the same time laying down the early foundations for the science of ecology. In 1749, he published an influential essay, "The Oeconomy of Nature," which declared that everything in the universe was "chained together" and that this interconnection demonstrated the "infinite wisdom of the Creator": "To perpetuate the established course of nature in a continued series, the divine wisdom has thought fit, that all living creatures should constantly be employed in producing individuals, that all natural things should contribute and lend a helping hand toward preserving every species, and lastly that the death and destruction of one thing should always be subservient to the restitution of another."[28] We see hints of the chain of being in this statement, which appeared in the introduction to the essay, but here Linnaeus is much more interested in the functional relationship between organisms in a given environment than a simple recounting of the series of creation. Central to this functional relationship is the observation that each animal not only feeds upon its own distinct prey but also is preyed upon by other species. Linnaeus offered several examples of this general phenomenon, including one that included multiple layers of predation: "Thus the *tree-louse* lives upon plants. The fly called *musca aphidivora* lives upon the *tree-louse*. The *hornet* and *wasp fly* upon *musca aphidivora*. The *dragon fly* upon the *hornet* and *wasp fly*. The *spider* on the *dragon fly*. The *small birds* upon the *spider*. And lastly, the *hawk* kind on the *small birds*."[29] In effect, what Linnaeus did here was delineate the ecological concept of the food chain, though naturalists would not adopt that precise name until nearly two centuries later.

Linnaeus also enumerated other patterns within the "economy of nature." Predators have fewer offspring, are less numerous in overall population size, and tend to live shorter lives than their prey. Each species exists within its own geographic range and eats a certain kind of food. Even particularly voracious "wild beasts and hawks" cannot "destroy a whole species." Rather, Providence has created an order that continually ensures a "just proportion among all the species,"

an order in which the complete loss of any species is inconceivable.[30] Linnaeus believed that ultimately this entire interconnected world had been made for the sake of humans—both to provide the things they need to survive and to offer a tangible reminder of God's power and glory.

Thus the wide acceptance of the chain of being and notions of a balanced nature both contributed to a generally static view of the world. Species could not go out of existence or come into being without fundamentally threatening that natural order. Ray, for example, remained unequivocal on this point: "The Number of true species in nature is fixed and limited, and as we may reasonably believe, constant and unchangeable from the first creation to the present day."[31] By the second half of the eighteenth century, some naturalists became more receptive to the possibility of limited change in organic nature. Linnaeus and his students, for example, toyed with the idea that hybridization might produce new species, while Buffon argued that the diversity of the natural world evident in his day was the result of the degeneration of a discrete number of basic forms.[32] But most naturalists refused to entertain the possibility of dramatic change in organic nature, and the complete loss of any species remained extremely problematic.

Scientists and other intellectuals in the West not only saw the world as static; they also believed it was relatively young.[33] Scriptural tradition played a central role in this assessment; the Bible recorded that the world had been created in six days, and it provided a written account of the early generations of patriarchs. In the seventeenth century, Archbishop James Ussher tried to nail down the exact date of creation by tracing these lineages while cross-referencing the people and events named in the Bible to the (still sketchy) historical record available at the time. Ussher's estimate—that the world began on the nightfall preceding Sunday, October 23, 4004, BC—gained further credence when church authorities incorporated it into annotated editions of the influential King James Bible translation.[34] While not everyone accepted Ussher's overly exact calculation, until the end of the eighteenth century, most educated Westerners seemed to embrace the notion that earth history and human history were roughly coeval and that the age of the earth was scarcely a few thousand years old.

THE PROBLEM OF FOSSILS

The discovery of fossils challenged firmly entrenched ideas about the order, stability, and age of the earth. Fossils—which we now define as the preserved remains of once living beings—had long been noticed, if not accurately identified. In a fascinating recent book, the folklorist Adrienne Mayor has documented the deep interest in fossils in the ancient world, where the "bones of gigantic beings

were treasured as relics of the mythic past and displayed as natural wonders in temples and other public places."[35] She argues that many of the mythical beasts from this period—the griffin, the centaur, and others—had their origins in fossil skeletons that were widely collected, measured, and displayed throughout the lands known to the Greeks and Romans.

That knowledge about fossil beings seems to have been largely forgotten, though, until the Renaissance, when the science of paleontology first began to stir.[36] By then, the term "fossil" denoted any distinctive object found below the earth or lying on its surface. It thus referred not only to fossils in the modern sense, but also to mineral ores, crystals, and rocks of all sorts. During the sixteenth century, the systematic study of fossils first took off when Conrad Gesner and other scholars began amassing large collections of these curious stones, producing illustrated publications describing them, and corresponding with individuals who shared their interests. These fossil objects tended to be interpreted within either Neoplatonic frameworks—which saw a correspondence between the hidden and visible worlds while positing a pervasive molding force or "plastic virtue" responsible for that correspondence—and Aristotelian frameworks that saw simple fossils as spontaneously generating and more complex ones as growing from a specific "seed" within the earth. Whichever explanation sixteenth-century naturalists adopted for the origin of fossils, they failed to show a particular interest in discriminating between organic and inorganic objects. And neither explanation for their origin raised the touchy issue of extinction.[37]

During the seventeenth century, naturalists not only began to take more interest in the resemblance between fossil forms and living forms, but also began to call those with a significant likeness to living beings "organized fossils" or "extraneous fossils." As historian of science Martin Rudwick notes in his pioneering study on the origins of paleontology, interpreting the meaning of these apparently organic fossil forms posed difficult challenges for early modern naturalists. While it was relatively easy to make the connection between so-called tongue stones and the teeth of living sharks, for example, other fossils presented difficulties because of confusing modes of preservation or a lack of familiarity with the organisms from which they had originated. Even in the case of fossils that clearly resembled living species, explaining their position (e.g., shells embedded high on mountaintops) proved difficult without adequate models to explain geological change. And in cases of fossils that appeared to be organic but did not seem to have living analogs, like ammonites, the specter of extinction haunted naturalists because it challenged deeply held notions about plentitude, the balance of nature, and the age of the earth.[38]

One scholar who struggled mightily with the problem of fossils in the late seventeenth century was John Ray. Ray was too accomplished a naturalist not to appreciate the strong resemblance between many fossil and living forms; moreover, his commitment to natural theology suggested to him that nothing in nature had been done in vain. He also benefited from the earlier publications of Nicolas Steno and Robert Hooke, who had argued convincingly for the organic origins of certain fossils in the 1660s and 1670s by using examples of remains whose form, composition, and position were relatively easy to account for.[39] Following a tour on the Continent, Ray completed an essay on the problem of fossils in which he called the hypothesis of organic origin the most "probable opinion," but one which he nonetheless found troubling.[40] First, the morphological differences between living and fossil species were enough to suggest that the latter were the remains of species that were extinct, a conclusion that flew in the face of some of Ray's most cherished assumptions. And second, the appearance of fossils in highly elevated areas, like the Alps, was difficult to explain using ideas of mountain upheaval as generally understood at the time, or by invoking the Great Flood, which soon became a common means of addressing this particular issue. As Rudwick points out, "the only way out of the dilemma was to argue that fossil species might not really be extinct at all" a conclusion that he terms "perfectly justifiable" at the time.[41] Most of the organisms in dispute were marine animals, which were little studied, especially those forms inhabiting remote areas. For the specific case Ray mentioned, fossil stalked crinoids, Ray's sense that it was too early to write off the species as lost gained vindication fifty years after his death by the discovery of living examples in the West Indies.[42]

The problem of fossils continued to challenge naturalists throughout the eighteenth century. The general confusion they provoked is amply illustrated in an episode from the early part of that century, when purported fossil remains became the center of a notorious scientific hoax.[43] Johann Bartholomew Adam Beringer, senior professor and dean of the faculty of medicine at the University of Würzberg, was a well-known collector of and expert on fossils. In May 1725, he hired three young men to excavate a promising site, a hill about a mile outside the town where the university was located. Over the next six months, his assistants dug up hundreds of fossil mollusks and small figured fossils from this site. But there was something odd about these particular stones: they featured a dazzling variety of forms, including a radiant sun with a human face, stars and comets, lizards, fishes, bees, frogs, and even Jehovah's name in Hebrew! Beringer was suspicious, as he should have been. Nonetheless, a year after he began trying to make sense of the bizarre stones, he published an illustrated book featuring

more than two hundred specimens from this site. After considering and rejecting various explanations for the fossils, he ultimately concluded that they had been created by "the Author of Nature" but were not the remains of any living creature. Only later did he discover that he had been the victim of an elaborate hoax perpetrated by two jealous colleagues.

Nonorganic explanations for fossils died out slowly during this period, and, if Rudwick is correct, the humiliation that Beringer suffered may have played a small role in their decline.[44] Yet, until the end of the eighteenth century, relatively few naturalists seemed willing to entertain the idea that fossils represented the relicts of extinct species. Linnaeus, for example, wrote of the fossil *Anomiae:* "the animals which inhabited these 'wild mussels,' as well as unaltered shells, are nowadays unknown to us . . . , nor do we know what in the world may have become of them. Still, we shall never believe that a species has entirely perished from the earth."[45]

Some naturalists at the time did begin arguing that the age of the earth was much greater than the generally accepted date of only several thousand years old. Based on estimates of the earth's cooling rate and his knowledge of fossils and sedimentation rates, in the late 1770s, Buffon argued that the world was more than seventy thousand years old, while privately speculating that the deposition of known geological strata would have required at least 10 million years.[46] Buffon thus became one of the first major Western thinkers to appreciate the concept of "deep time," a wonderfully evocative phrase coined by the twentieth-century American writer John McPhee.[47] The Scottish geologist James Hutton went even further in his landmark book *Theory of the Earth* (1795). There he argued that much of the earth's surface consisted of the relicts of sea animals that had been deposited on the ocean floor, consolidated into strata, and then pushed upward by the heat of the earth. All this took so much time, Hutton argued, that when it came to estimating the age of the earth, there was "no vestige of a beginning,—no prospect of an end."[48] Even with these and other expansions in the earth's time scale, though, resistance to the idea of extinction remained solid. As Rudwick summarizes the situation at the end of the eighteenth century: "Whether any species had truly been 'lost' from the world thus remained a question as uncertain and debatable at the end of Buffon's life as it had been nearly a century earlier at the end of Ray's. Many groups of fossils, such as ammonites and belemnites, were now recognized beyond all doubt as organic remains differing radically from any known living animals; but it could still be asserted with good reason that they might be living in deep water or in some remote part of the world."[49] The discovery and careful examination of large fossil mammals would soon present insurmountable obstacles to that claim.