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Ecology Then and Now

As a word, ecology has been so debased by recent political usage that many people employ it to identify anything good that happens far from cities and without human interference.

Stephen Jay Gould, An Urchin in the Storm

Ecology as Point of View and as Science

In the 1960s, ecology began to be popularized in the United States as one of the many utopian discourses for which the decade was both a watershed and, in the end, a burying ground. But the discourse of ecology was luckier than others: its credibility was strengthened both as the sixties wore on and in the decades to follow, despite the rise of neo-conservativism, which was quick to dismiss all things associated with the sixties as nonsense, and notwithstanding a general atmosphere, in the culture at large, of reaction and retrenchment. As a result, ecology has come to be identified in the popular mind with such values as balance, harmony, unity, purity, health, and economy. It's fair to say that many people regard these values, however utopian they may be, as all but indisputable and as all but synonymous with the very word "ecology." Few laypersons dare to question these values publicly, and imagery expressing our collective devotion to them, and indeed to everything green, pervades our daily lives. For those who applaud the apparent improvement in our attitude toward the natural world over the past forty years, the thought that the values of balance, harmony, unity, purity, health, and economy have something other than a transcendental basis—the thought that, unlike other utopian values, they are supported by ecology, which is to say, by all the authority of science—is a source of comfort and confidence.

In this chapter, I am going to violate what amounts to a taboo: I am going to argue that our confidence in ecology has been misplaced, or rather misjudged, and that we have been overly credulous when listening to its popularizers. The values to which ecology dedicated itself early on—especially balance, harmony, unity, and economy—are now seen as more or less unscientific, and hence as "utopian" in the pejorative sense of the term. And they are seen that way not only by critics who have a vested interest in distracting our attention away from a deteriorating natural environment, and who like to dismiss all ecological concepts as so much moonshine (lobbyists for oil companies, American automobile manufacturers, their bootlicking government apologists, and the like), but by a growing number of ecologists as well, who are, needless to say, in a position to know whereof they speak. Precisely because the values in service of which ecology was founded in the late nineteenth century were utopian, no one was certain of their meaning, and so they either gave rise to endless debate and speculation, or were abandoned as utterly impractical by dissident ecologists sometimes branded as heretics by their peers. I am going to try to show that the dissidents turn out to have been right all along.

To complicate these matters still further, another aspect of the story of ecology needs to be highlighted before I begin telling that story in proper chronological order and in detail. For it isn't just ecology's core values that have been cast into doubt and rejected as unfeasible: the situation is much more dire than that. Because its original objects of study—supposititious entities such as, for example, the *climax forest*—were not only poorly defined and poorly described but were also of debatable reality, ecology's history has been marked by conflicts growing out of a lack of consensus about the parameters that should guide the statement of hypotheses and the conduct of research. In other words, ecologists have not been able to agree about what actually counts as ecology. *Basic ecology*, that is, not cutting-edge or revolutionary ecology, but the sort of workaday science a Kuhnian would describe as "normal."[1] Ecological theories have tended to arise and flourish only very briefly, before their flaws are exposed by poor experimental results and by the keen eyes of critics.

These critics have pointed out, with almost monotonous regularity, that (1) ecologists need to define and describe their objects of study in terms unlike those used by other scientists, so that their own research will have a distinctly ecological content and a unique fund of core concepts on which it can draw; that (2) ecologists also need to find out how to work with the things they study experimentally, in a fashion that will help make ecology truly distinct from other kinds of biology; and that (3) both of these things have proved very hard for ecologists to do, and not for lack of effort. Ecologists have been forced, time and again, to borrow the terms and concepts of other sciences, as well as their objects of study and methodologies. Ecology's chronic indebtedness to other sciences has had the effect of making it appear overly metaphorical to outsiders, who often have regarded it as a fuzzily defined and value-ridden "point of view," rather than as a coherent scientific enterprise in its own right.[2]

So it was that beginning in the late nineteenth century, and for a long time thereafter, ecologists tried valiantly—and in many cases, vainly—to give their discipline a foundation of well-established facts and agreed-upon theories of the sort enjoyed by other sciences, especially physics, which seemed, rightly or wrongly, to be the very standard of objectivity and theoretical probity. Ecologists wanted to join in the family business of science without having constantly to review their intellectual pedigrees and capital resources. They knew that shoring up a scientific discipline's

foundations always means discovering and coming to terms with the fundamental forces, processes, entities, and mechanisms on which the discipline's efforts to understand nature, whether only in part or as a whole, must focus. Thus they found themselves struggling with awkward problems of scientific methodology, and asking difficult questions, first about what it really means to identify nature's cogs and wheels, and second about how one might, having identified them, then go on to describe the workings of those cogs and wheels. For starters, many ecologists wondered if mechanistic language of the sort I've just used should not be rejected out of hand as an implicit betrayal of everything that the word "ecology" implied. They thought organic metaphors might be more appropriate to the study of nature; in fact, many of them thought such metaphors really might not be that metaphorical after all, since they felt sure that nature itself was one vast organism, the parts of which formed a seamless whole.

Because there are a number of respects in which the discipline still struggles to define itself today, even if it no longer feels quite so abashed in the presence of an all-mastering, apparently all-powerful physics as it used to feel, in the pages that follow I am going to be especially concerned to explore the gap between ecology as a "point of view" and ecology as a science. Exploring this gap is a task incumbent upon anyone seriously interested in environmentalism and natural history, a task that in my view ecocriticism has put off for far too long. Further delay will mean that ecocriticism also continues to fall between two stools, and whether this will confirm its claim to be interdisciplinary or will cast doubt on it is unlikely to require a judgment call. As things now stand, ecocriticism is open to the charge that it, too, is no better than a "point of view," and a second-order one to boot, since in order to support its own assertions about how the green world is structured and functions, ecocriticism must appeal to and look over the shoulder of another discipline, which it supposes to be situated much closer to the action (to nature, that is).

In situations like this one, in which one discipline wants to piggyback upon another, an academic version of the tragedy of the commons transpires, as the space between disciplines gets treated as if it abounded in exploitable resources and as if it were infinitely divisible; and before long, range wars begin to erupt. Still more fundamentally, something like Zeno's Paradox comes to be in effect, so that assertions made by those working in one discipline never really connect with their targets in another, all appearances of good will and acquaintance with the facts to the contrary. To put the point I am making in yet another way, in interdisciplinary work of the kind that ecocriticism purports to be, the gaps between disciplines, especially the infamous gaps between the arts and the sciences, are apt be papered over rhetorically. All too often, little or no effort is made to confront these gaps directly and to bridge them argumentatively, where that is plausible (sometimes, of course, the gaps are simply unbridgeable, and the disciplines may have little, if anything, to say to one another). The inevitable result is that basic errors of fact and interpretation, especially of the latter, are perpetuated under the banner of interdisciplinarity.

For ecocriticism to be of substance as an interdisciplinary field, it needs to realize that ecology is not a slush fund of fact, value, and metaphor, but a less than fully coherent field with a very checkered past and a fairly uncertain future. I suspect that many ecocritics would be dismayed to learn that despite ecology's heroic popular image, it has been characterized as a relatively lightweight science by informed observers whose criticisms of it cannot be dismissed as mere carping, even if those criticisms have sometimes been too harsh, above all when other biologists less taken with fieldwork than ecologists are have held the floor.[3] In point of fact, ecology has not enjoyed as great a record of success as the other life sciences have. Nor has it always been entirely in line with the ethos prevailing in those other sciences, and this maverick quality has proved to be much less of a virtue than it once was assumed to be.

The divergence of ecology from what is widely regarded as the scientific norm becomes especially clear when it is compared to molecular biology. As a macrobiological science, ecology appears to be fundamentally at odds with microbiology, which has provided the dominant model, both theoretically and methodologically, in the life sciences since the late nineteenth century, owing in no small part to its tremendous successes, of which it should suffice to mention only the discovery of DNA as a leading example.[4] By bucking the trend toward reduction in biology, ecology has found itself in the unhappy position of seeming to disrupt the unity of the sciences. This is an especially embarrassing circumstance for a discipline in which a great deal has been made of unity as the supreme value established by nature itself. In light of this circumstance, it is clear to me that ecocriticism will have to abandon its rather mystical view of ecology as the binding force holding together not only all of the sciences, but nature and culture as well. Ecology sparks debates about environmental issues, it doesn't settle them; and it also sparks debates both about what should and shouldn't count as science, and still more fundamentally, about what should and shouldn't count as nature.

In all fairness, however, one has to note that ecology's reputation as a maverick science actually rests largely on a number of overstatements made by its popularizers, of which there has been no shortage, and hence on a series of false impressions. In fact ecology is not so radically different from other sciences as has been thought and said.[5] To point this out is not to gainsay ecology's differences from other sciences; it is, instead, to make those differences seem appropriately relative. Ecology's reputation as a science wholly unlike others is largely an artifact of its being still in the early stages of development after more than a century. Its rather halting progress toward maturity has gone mostly unnoticed, except in specialist journals and monographs, and this oversight has contributed greatly to a general misunderstanding of ecology's character, especially on the part of those who have wanted to procure its blessings for political purposes—or merely to credit themselves with some of its graces, as ecocritics arguably have done.

Given the abuses to which ecology has been subjected by its admirers and its detractors alike, it is crucial to understand that despite the popular image of its prac-

titioners as easygoing, nature-loving outdoor types with an eccentric affinity for newts, shellfish, algae, lichen, prairie grasses, and other life forms lacking in charisma, ecology is in many respects an extremely difficult science. That it is so difficult does much to explain its slow and uncertain advancement. Newts, shellfish, algae, lichen, prairie grasses, and the like aren't necessarily easy to know: docile and even immobile though they may be, they lead inordinately complicated lives.[6] This fact alone makes our misapprehension of ecology's true character very important to recognize as such. We want ecology to simplify things for us, and that is something it really cannot do.[7] Nonscientists often demand that science serve us as an augury of our collective fate. But this is a service science is usually unable to provide honestly and in the unambiguous terms that we nonscientists would like it to use.[8]

The distortion of popular ecological rhetoric reflects something more, however, than just the allure of utopian thinking and prophetic posturing. It also expresses a widespread distrust of science, which more often than not can be measured in units of ignorance, and which may very well mark the site of a massive cultural contradiction. We all want science to tell us what to expect in the future, but at the same time most of us really don't like to hear what science has to say. Many people believe that ecology is a science unlike others because by embracing holism it is supposed to have avoided the pitfalls of mechanistic reduction. Yet few if any practicing ecologists share the distrust of science attributed to them by those who glamorize and misrepresent their work. The same institutions that train physicists and molecular biologists, often vilified as the most reductive scientists of all, also train ecologists, who imbibe assumptions about methodology similar to if not identical with those that their peers in other disciplines are weaned on. Ecology's research agenda is increasingly directed toward making it look more like the harder, more mechanistic and reductive sciences, not less: and inevitably so, since it seeks "the same kinds of explanation as are sought in the other sciences."[9]

In pursuit of explanations that will stand up under the scrutiny of other scientists, the claims of ecologists about the natural world have become both much more specific and a lot more tentative over the past forty years, which explains the whiff of paradox that seems to hang about the more startling of their claims. Those claims tend to cast doubt on the practical importance of values like harmony, balance, unity, and economy in the day-to-day functioning of actual natural systems; in fact, they even call into question the very idea that nature contains anything so self-regulatory and so thoroughly integrated as to justify the use of the word "system" to describe it in the first place. The increased modesty of ecology, both in theory and in practice, also explains why and how its utopian impulse has been muted, if not rooted out altogether. Utopian yearnings are best expressed in glittering generalities, and ecologists have learned to be extremely wary of those; hence their current willingness to be more "reductive" than they were in the past. Curiously, their newfound willingness to be "reductive" also has had the rather surprising and possibly quite liberating effect of making ecologists more adventurous, where some cutting-edge ideas like chaos theory are concerned.

In any case, one can assume that the utopian aspect of their science always seemed less prominent and less promising to most ecologists than it did to conservationists, environmentalists, and other onlookers from outside the field. But as it so happens, the lay celebrants of ecology as a utopian discourse have included a number of people in a position to know better. They have tended, however, to ignore or downplay the cautionary statements made by practicing ecologists, when they haven't rejected them outright. One of the most prominent of these people, the environmental historian Donald Worster, is very much a case in point: he continues to exaggerate the scientific credibility of an old-fashioned variety of ecology that he finds more congenial than the skeptical variety that replaced it years ago.

I realize that for me to take issue with Worster may seem, to those who are familiar with his work, like hubris. For that matter, for me to try and tell the tale that I relate in this chapter also may seem like hubris, lacking in the relevant credentials as I am. And it may seem unnecessary as well, since Worster and other environmental historians have reported the story of ecology since its beginnings in the late nineteenth century already, and have done so in detail and very ably for the most part. They have focused on the development of ecological theory, on the genesis and growth of schools of research, and on the application of ecological science to questions of agricultural policy and to watershed, forest, and wildlife management, a roster of topics that might seem to exhaust the subject matter. This subject matter is one about which environmental historians are very keen, since they tend to be committed environmentalists in their own right, making their interest in ecology more than academic—as no doubt it ought to be.

However, for my purposes and for the purposes contemplated by ecocriticism, the stories that environmental historians have told about ecology need to be given a different and a less celebratory emphasis, so that the peculiar intellectual difficulties ecology faces, which have cropped up in all stages of its development as a science, can be underscored and addressed as frankly as possible, and in a more philosophically probing way than they have been in the past. This is particularly true, in my view, of the stories that Worster has told about ecology: his book *Nature's Economy*, which approaches the development of ecology from the vantage point of intellectual history, is often the only source that ecocritics cite in support of their claims about the natural world and the growth of our understanding of it.[10] That they should rely on Worster's book to the exclusion of others may be only natural, if you'll pardon the expression, since Worster is widely acknowledged as the dean of environmental historians—indeed, as one of the founders of the field of environmental history itself, in which the initial publication of *Nature's Economy* in the late 1970s was a seminal event.

However, to my way of thinking, Worster's influence on ecocriticism is unfortunate, and while some, at least, of the template I have relied on in telling my own story about ecology is borrowed from my reading of his work, I've also tried to incorporate in that story both the views of other environmental historians and of philosophers of science, and as much direct testimony from ecologists themselves as I could digest in an intelligible way. I've found this hands-on and ambidextrous approach to the history of ecology necessary in order to compensate for the distortions of those ecocritical statements on the subject that are quite purely and simply naïve, and with regard to cases where such statements have been better-informed, in order to counterbalance the influence on ecocriticism of Worster's work.

Worster's remarks about the increase in theoretical modesty in ecology since the 1960s demonstrate that he has little sympathy for the scruples ecologists increasingly feel. In fact, he expresses a prickly disdain for those ecologists who have pointed out the stumbling blocks strewn across the path of the discipline's progress as a science, and treats their misgivings as symptoms of intellectual timidity and a loss of faith in the ecological vision. Worster even goes so far as to hint that their expressions of doubt about such classic ecological concepts as, for example, the ecosystem may be politically motivated. "For some scientists," he writes, "a nature characterized by highly individualistic associations, constant disturbance, and incessant change may be more ideologically satisfying than Odum's ecosystem, with its stress on cooperation, social organization, and environmentalism."[11] Because of passages in which he makes insinuations like this one, Worster's work strikes me as biased, and in fairly obvious ways.

There is no doubt that the trend of recent ecological science toward revision makes life more difficult for the environmental historian, since it's harder to hit a moving target than a still one. But this doesn't mean that ecology has become ideologically suspect or is asleep at the switch, as Worster alleges.[12] He seems to think that the difficulty environmental historians face in constructing their accounts of ecology's development is not a historiographic difficulty, but is to be explained in terms of the changed character of the science since the 1960s. In other words, he seems to think that the object of study is to blame for the difficulty the historian of ecology faces when he or she tries to describe it accurately.[13] What Worster dislikes most about contemporary ecology is, essentially, that it is too much prey to the vicissitudes of science—that it is overly influenced by the evidence presented to it, evidence which runs contrary to some of the classic assumptions of the field. Worster thinks contemporary ecology ought to be more stouthearted ideologically, and ought to resist falsification more strenuously than it does. Environmental history, he writes, now has to contend with a science "caught in the middle of a revisionist swing that has left in some disarray the notion of what an ecosystem is and how it works, that has even cast doubt on such old intuitive notions as 'the balance of nature' and the role of diversity in promoting ecological stability."[14]

Such is Worster's fondness for those "old intuitive notions" that he actually understates the extent to which doubt has been cast on them and has left them in disarray.[15] He does so, I think, because he wants ecology to provide something more than sustenance for environmental historians hungry for fresh subject matter. He wants ecology to provide guidance, too, and not just guidance of a scientific kind. He would like to be able to depend on ecology as a moral compass, and he makes it clear that he is disappointed in "the new ecology" because its "lessons" are "not at all clear."[16] The new ecology, in Worster's eyes, is morally as well as politically suspect, since it is more value-neutral than the old, and therefore less socially and politically useful in the short term. As one of his colleagues, Richard White, has argued, "Worster's account of environmental history is as much a prescription as a description." White thinks Worster's influence on the field of environmental history has been less than entirely healthy: "Having defined the field, Worster outlines what might be called its methods. Here, however, under the guise of stating conventional wisdom, he is trying to create it, or rather to impose a much older construct on the field."[17]

Environmental historians have tended to be hopeful, and a little prescriptive, in their appraisals of ecology, White argues, because they have tended to be hopeful and a little prescriptive about environmentalism. He writes:

> Environmental historians once thought that they had a firm basis for their morality and causality. Historians read the science of ecology as both detailing basic natural processes and yielding certain moral verities: complexity is good, simplicity is bad; natural systems seek equilibrium and battle disruption; there is an ideal balance in nature that, once achieved, will maintain itself. Those verities gave historians standards against which to measure and evaluate the repercussions of human action.

Now that the verities of ecology have been shown to be less than wholly veritable (or less than wholly verifiable), White suggests that environmental historians also have been plunged into uncertainty: "Historians thought ecology was the rock upon which they could build environmental history; it turned out to be a swamp." White also suggests, on the other hand, that it is possible to overreact to the apparently dramatic change in ecology's character. He reminds his reader that although in popular usage the term ecology is used loosely to refer to "nature," its referent "is, in fact, only an academic discipline."[18]

Ecology of the holistic sort that, like other environmental historians as well as many ecocritics, Worster still idealizes, has passed out of fashion largely because of the poor results it generates when put to the test experimentally. Many ecologists now see concepts like cooperation and social organization, when applied to the natural world, as ambiguous at best and irrelevant at worst. These ecologists are still very much committed to environmentalism, even if they don't express their com-

mitment in the glowing, uplifting terms that environmentalists would prefer them to use. Ecologists have begun to hold themselves accountable to more exacting standards in recent decades, which has made them less available and less pliable as spokespersons for the environmental movement.

Like many members of the American environmental movement, Worster is a sort of populist. On his view, all kinds of things—certain religious beliefs and rituals, for example, not to mention any number of literary texts—can be counted as "ecological" even if they have no bearing whatsoever on our scientific understanding of the natural world. This explains the great attraction of Worster's work for ecocritics, who are also populists of a sort, and who therefore would like to think that ecology is readily accessible to anyone who is able to read certain primary texts, to appreciate certain kinds of symbolic behavior, and to savor both pastoral and pristine landscapes. Especially in *Nature's Economy*, which is regarded as a classic of environmental history largely as a result of its being one of the first synoptic accounts of the subject, Worster construes the history of ecology very broadly—so broadly that he conflates it with the history of cultural movements like Romanticism, when its resemblance to those movements is much more apparent than real. Worster argues that the "Romantic approach to nature" is "fundamentally ecological" because it is "concerned with relation, interdependence, and holism."[19] In effect, Worster concedes the main point to its critics by treating ecology as if it really were no more than a "point of view," one that can be adopted more or less readily by those gifted with a modicum of imagination.

The ecologist Robert McIntosh has noted that because Worster overlooks some of the stark realities of the historical record, he grossly overstates the importance of literary natural historians like Gilbert White of Selborne and Henry David Thoreau to ecology. McIntosh suggests that "retrospective views of ecology" often produce little if any evidence that the work of writers like White and Thoreau, however intuitive those writers may have been about natural history, actually "was connected with, or led to, that of later workers. That brilliant ideas have been amply studied, elegantly expressed, and even published without having influenced the work of contemporary scientists is familiar in the history of Gregor Mendel's lonely efforts."[20] The fact that the great majority of ecologists did not and do not read either White's or Thoreau's work as being ecological, if they read it at all, and the fact that they did not and do not regard White and Thoreau as fellow workers in the field, should be decisive. Curiously, Worster doesn't take these facts into account, nor do those ecocritics who have been following his lead in constructing their own narratives about ecology, narratives in which White, Thoreau, and their ilk play a central role.[21]

While a few of the stumbling blocks strewn across the path of ecology's progress as a discipline have surely been ideological, much as Worster alleges, most of them have been—and are—all too real. They cannot be wished away, or made to vanish

by a change in attitude and outlook or "point of view," no more than the gap between literary natural history and ecology can be eliminated simply by conflating the two in a sweeping narrative of intellectual history focused on ostensibly Romantic ideas. The misgivings that ecologists first began to express in the 1960s originate in a struggle with problems grave enough to call into question, yet again, ecology's status as a science. If ecology has been a success as a science, it has been a very qualified one: research in the field continues to advance and retreat along a wavering, uncertain front. What previous generations of ecologists regarded as black-letter scientific truths, or "laws of nature," the current generation treats as so much wishful thinking. More or less out of necessity, many ecologists have become quite sophisticated about the theoretical and philosophical difficulties with which their discipline is beset. These ecologists use words like "truth" and "law" only very tentatively and somewhat apologetically, if they use them at all. They have ceased to be students of the absolute and the unchanging, and have become students of the probable and the ever-evolving.[22]

Notorious as the perils of disciplined, undisciplined, and interdisciplinary academic work are, it nonetheless is puzzling that the overstatements, misstatements, and misinterpretations I have described should have been perpetrated so often. Why assume that ecology is what the slogans of the environmental movement say it is? Why treat a writer like White or Thoreau as an ecologist, when history clearly demonstrates otherwise? In other words, why premise the value of their writing on its anticipations of what may or may not come to be counted as ecological principles, especially since such anticipations can only be, in the nature of things, vague at best? Historical and literary scholars are much too easily tempted to tell seamless stories about the things that interest them by discovering family likenesses and postulating common points of view where none exist.

Like other scientists, ecologists have to acknowledge the difficulties they face sooner rather than later, and as forthrightly as they can. They also have to find practical ways of overcoming those difficulties. Thus there is a danger that those who, like myself, are interested in ecology, but whose training is not scientific and who must cope with an entirely different set of difficulties, will gloss over or minimize the significance of the problems ecologists face in understanding the natural world. Ecocritics have seized upon ecology as an accessory and complement to their own brand of professional discourse because of their commitment to environmentalism, and because they have thought that ecology offers scope for the vibrant depiction of a natural world conceived of organically. The latter is something that literature used to offer, until theory had its way with it—or so it is said. But not all of the workings of the natural world are organic, and most of them are far from obvious. The truth, as I hope to demonstrate, is that the history of ecology has been one of discovering how much unlike an organism and just how nonobvious the natural world can be.

From Analogy to Algebra

> *The world . . . is never simple; it doesn't even provide apt metaphors.*
>
> *Stephen Jay Gould,* An Urchin in the Storm

The German morphologist Ernst Haeckel coined the term *oecologie* in 1866, but without ever doing any actual research in the field. Unfortunately—or so it seems from the environmental historian's perspective—this means that the origins of ecology cannot be traced solely to Haeckel.[23] Nor, for that matter, can they be traced to any other single theorist and researcher. The murkiness of ecology's origins is a reflection of the fact that substantive existence as a science proved very difficult for it to come by. For instead of being founded on new discoveries that opened up original avenues of research (on a so-called Copernican revolution), ecology was inspired by misgivings about reduction as a central tenet of scientific theory and methodology. It was thought that by being reductive in such a thoroughgoing way, scientists were running the risk of breaking the butterfly upon the wheel, hence of traducing the very vision of nature that gave science its grandeur and nobility as a human endeavor, not to mention its moral and philosophical sanction.

Given its origins in a reaction against an entrenched status quo, it was inevitable that a few researchers found themselves doing ecology almost before they were aware that this might be the proper name for what they were doing. Casting themselves, implicitly or explicitly, as a new breed, these ecologists-in-all-but-name insisted that important biological processes were at work at levels other than that of the individual organism, population, or species, and they proposed that these processes should be investigated *in situ*—in the field. Both by default and by design, their research agenda was at odds with the general trend of the biological sciences toward greater specialization and a narrowing focus on smaller and smaller entities easy to experiment with in a controlled setting, such entities as monkeys, rabbits, mice, fruit flies, microbes, single cells, and (eventually) strands of DNA. Ecologists were beginning to do macrobiology and fieldwork at the very moment when other scientists had become convinced both of the primacy and, more important, of the practicality and greater utility of microbiology and laboratory experiment. To other scientists, ecologists appeared to be taking a step backward, and were simply mistaken to think that they had found a new way of understanding the natural world.

The distinguished evolutionary theorist and ornithologist Ernst Mayr explains that the origins of ecology involved a departure from older ways of doing natural history through the adoption of more up-to-date assumptions about scientific method: "Natural history had to become explanatory. It continued to do what natural history had always done—observe and describe—but by applying other scientific methods to the observations (comparison, experiment, conjectures, testing of explanatory theories), it became ecology."[24] But in its early years and for many years thereafter, the new science's departure from natural history was probably more apparent than real. Despite the trappings of improved method with which it had adorned itself, ecology continued to cling to some of the bad habits that other forms of science were struggling to give up, including "observation, description, and an inductive approach."[25]

In the United States, ecology did not begin to be recognized as such until three decades after Haeckel first coined the term, which botanists were the first scientists to use. As a result, many of the earliest ecological concepts to be developed and disseminated in the United States were limited in application by their botanical bias.[26] Botanical concepts of ecology emphasized static, visually obvious features of the natural world at the expense of others. Simply by virtue of the fact that plants are stationary and are usually the first living things that we see when we enter an unfamiliar landscape, they are, quite literally as well as figuratively, much easier to grasp than animals are, both as individuals and collectively.

Early work on so-called plant communities was dominated by the idea of *succession*. According to this idea, the order in which plants colonize the newly barren ground of a disturbed site follows a standard script and is coordinated between species to a high degree. So powerfully attractive was the idea of succession that ecologists assumed its order must be determinate, which meant that if the relationships governing it could be discovered and precisely described, succession might be treated as a predictable process—and as a platform for experimentation in the field. Ecologists also assumed that succession, being determinant, was teleological: that it would continue to unfold until a dominant plant or group of plants became established, in habitats favorable to the dominance of that plant or group of plants (clearly, a certain amount of circular reasoning help to make the idea of succession seem plausible). The "ecology" of each habitat was therefore identifiable, and could be expressed in terms of the dominant vegetation, which would persist in a relatively stable state (called "homeostasis") provided that it wasn't disturbed or destroyed by drought, flood, wildfire, disease, parasitic infestation, human intervention, or a catastrophic change of climate. Until and unless one or more of these things should befall it, a habitat could be labeled a "pine forest," an "oak savanna," a "tall-grass prairie," or what have you, and managed (i.e., left to fare as best it could) accordingly. Most importantly, ecologists insisted that the value of these descriptive labels was more than pragmatic, which meant that they were not to be regarded as mere place-markers, since they denoted actual living things. A pine forest, an oak savanna, or a tall-grass prairie wasn't just a coincidence of natural history. Each of these habitats could and should be treated with all possible rigor by researchers as a single entity: as an organism, and even as a species.

One of the earliest attempts by an American botanist to describe the ecology of a particular habitat can be found in Henry Chandler Cowles's 1899 article, "The Ecological Relations of the Vegetation on the Sand Dunes of Lake Michigan." Also to be found there is one of the earliest American definitions of ecology, a definition in

which the botanical bias is evident. "The province of ecology," Cowles wrote, "is to consider the mutual relations between plants and their environments." The best way "to consider the mutual relations between plants and their environments," he suggested, was to "study the order of succession of the plant societies in the development of a region" and to "endeavor to discover the laws which govern the panoramic changes." He summed up by characterizing ecology more abstractly and more philosophically as "a study in dynamics." Sand dunes are in fact among the most dynamic and changeable of landforms; as Cowles admitted, "The dune-complex is a restless maze."[27] This means that the "plant societies" of the sand dunes are also much more dynamic and changeable than vegetation seems to be elsewhere (in an old-growth forest, for example). For this reason, Cowles was tentative in his conclusions about the ecology of "plant societies," a lot more so than other botanists were at the time. He realized that panoramic changes, or gross alterations in the visual appearance of ensembles of plant species, might not have an inherently *biological* meaning. They might reflect instead such nonbiological factors as, for instance, catastrophic soil erosion brought on by floods or high winds.

Perhaps the least tentative of early plant ecologists was Frederic Clements, whose career began when he was a graduate student studying botany at the University of Nebraska in the 1890s. Clements was a leading figure in American ecology before the Second World War. Two of his ideas, *climax* and *the organismal concept*, were accepted widely by other scientists at one time, and remain part of the popular conception of ecology today (regrettably so). The two ideas are really one: according to Clements, the climax is "a complex organism inseparably connected with its climate and often continental in extent." The climax has "visual unity" because of "the life-form of the dominants, which is the concrete expression of the climate." In other words, the climax is hard to overlook. It tends to be obvious, much in the same way that mountain ranges are obvious. The climax might take the form of a great hardwood forest in which the beech tree seems to be the predominant species, or it might take the form of a boreal forest in which one or two species of conifer far outnumber other kinds of tree, in a wide belt of vegetation almost circumpolar in extent. Such climax forests constitute superorganisms, Clements argued, not only by virtue of their tremendous size and vast biomass, but also because they have developed in the same way that a single organism develops both ontogenetically (i.e., during its own life span) and phylogenetically (i.e., from its ancestor organisms).[28]

Clements didn't treat the organismal concept as an analogy, though that is what it was. Nor did he treat it as a metaphor, though that is how it tended to function in his theories. He regarded forests, grasslands, and the like, especially if they had reached the stage of climax, as organisms strictly speaking and as evolutionary units, because in his view they just *were* those things; in fact, in his view they were, to all intents and purposes, distinct species. Clements's theories appealed to other ecologists, one suspects, chiefly because they seemed to give ecology an especially firm grip on the natural world. A Clementsian ecologist did not hesitate to treat a

particular forest or grassland as a separate species, rather than as a unique instance or coincidence of vegetation. To such an ecologist, isolating a single quadrat (of, say, ten square meters) in an area (of, say, ten square kilometers) where climax had been reached seemed to be an entirely reasonable procedure, rather like taking a tissue sample (ecologists have always found it hard to resist physiological analogies). Counting the species within a quadrat, multiplying by the appropriate factors, and comparing the resulting data with data generated by the study of another quadrat located in a similar area of forest or grassland nearby, possibly one disturbed by fire or abnormally intense grazing due to an overpopulation of deer, also seemed like reasonable procedures. Clementsian ecologists were sure that their methodology was both theoretically sound and pragmatically grounded, and that the results it generated were wholly reliable. For within a given climax, one quadrat was as valid a sample as another, *by definition*; and it was assumed that forests and grasslands all followed similar orders of succession.[29]

But Clements's enthusiasm for the organismal concept led him to gloss over or deny its inconsistencies, of which a few, at least, of his contemporaries were fully aware.[30] In its strongest, most metaphorical, indeed almost mystical and hence most vulnerable form, the form in which Clements actually promoted it, the analogy between the climax and the mature organism was said by his critics to be a false one.[31] It ignored the many important and quite obvious differences between mature grasslands or forests, and adult animals or plants. Grasslands and forests aren't really very similar to organisms at all, much less identical to them. But Clements was dogmatic: despite the glaring defects of the organismal concept, he built an elaborate structure of explanation centered on the idea of the climax. He also identified a number of stages of development leading up to and following the climactic stage, and devised a cumbersome Latinate vocabulary in order to keep track of them all.[32] His theory was bound to collapse of its own weight eventually.

It's worth noting that Worster, who clearly sees Clements's theory as an instance of the visionary, Romantic ecology he most admires, has explained its fate rather differently than I have here. Worster suggests that the climax concept was directly in competition not only with scientific orthodoxy (which in this case was truly on the side of righteousness) but also, and more importantly, with Frederick Jackson Turner's Frontier Thesis and the epic of nation building described by James Fenimore Cooper in his Leatherstocking novels. In Worster's view, the climax concept has something crucial in common with both Turner's and Cooper's ideas about America's growth and development. He suggests that Cooper, Turner, and Clements shared a similar intellectual disposition, and points out that all three attempted to define the basic character of historical processes in terms of the unfolding and eventual fulfillment of grand narrative designs. He also notes that all three men enjoyed thinking about the American countryside as a vast stage on which events of historic importance could take place: that there is a spatial as well as a temporal dimension to each man's thinking. But Worster argues that, all similarities

aside, Clements's views were fundamentally in conflict with those of Turner and Cooper, and therefore had to yield under pressure of national necessity:

> According to the Turner-Cooper view of national development, a mature and complex civilization must emerge out of the pathfinding exploits of a ruder culture; Clements and the mainstream of Anglo-American ecology offered a similar view of the evolution of the biotic community. But the two processes were fated to meet, it seemed, in irreconcilable conflict. One would have to give way to the other; it was not possible to have both a climax state of vegetation and a highly developed human culture on the same territory.[33]

Worster is right to note that the Leatherstocking epic, the Frontier Thesis, and the concept of the climax state are each ways of giving progressive shape to what otherwise might seem like anarchic or chaotic processes. Superficially, at least, the three are similar. That, however, is probably the merest coincidence, and Worster is mistaken to argue that the concept of the climax state was bound to be rejected, not because of its weaknesses as a scientific concept, but because it was ideologically unpalatable and could not compete with what had become a central tenet of the orthodox view of American history.

Worster treats both the superficial resemblances between the concept of the climax state and the "Turner-Cooper view of national development," and the differences between them, as more meaningful and less coincidental than they actually are. I would argue that this demonstrates the inherent weakness of the "history of ideas" approach to understanding ecology. (I think it also demonstrates the inherent weakness of any strategy that involves carving out new territories for interdisciplinary work by filling in the spaces between disciplines with spurious analyses and interpretations.) The concept of the climax state did have "to give way," but not because it was in ideological conflict with the views of Turner and Cooper; to be that, it would have had to be more in contact with them than it is likely to have been. In the event, things were much less dramatic than Worster would have us imagine: the concept of the climax state had "to give way" because of its inconsistency as a scientific concept and because of its great impracticality, neither of which were immediately apparent to Clementsian ecologists for a variety of reasons, not least among them the fact that these were still early days.[34] Clementsian ecology was not overcome on the field of ideological battle; it just petered out, through increasing lack of interest in its ideas.

The plant "community" and the "organismal" climax forest are only two examples of the charm that analogy held for the first few generations of ecologists, and perhaps it is to be expected that the key concepts of a new science will be of an essentially analogical character. Theorists and researchers know that they need to develop a distinctive approach to nature if their work is to be recognized as innovative science, and one way to begin developing such an approach is by suggesting some

original and striking analogies, preferably ones that play off one another in a more or less integrated fashion. In the late nineteenth and early twentieth century, ecologists realized that they needed to treat nature in terms and using tools other than those used in taxonomy, which emphasized the identification and description of individual species, and the collection of numerous specimens of those individual species. In principle, taxonomy was never-ending and never cumulative, at least not in a way that satisfied ecologists. They hoped to discover the broader categories in terms of which nature was organized and structured biologically, and to devise practical ways of demonstrating the functional reality of those categories experimentally. In attempting that discovery and demonstration, ecologists tended to emphasize the similarities between things, and between different orders of things, more than their differences. Analogies helped them do so.

Focusing on the similarities between natural phenomena seemed to offer early ecologists a means of extending their understanding of a few relatively well-explored aspects of natural history into new areas of research. They assumed that to extrapolate from one discipline to another (say, from botany to ecology) and from one level of biological functioning to the next (say, from the individual plant to the plant community) would be a reliable procedure because it was a reasonable one. They felt sure that the biology of individual species provided ample information about the ecological relationships obtaining between species, and between whole groups of species and their habitats. They also felt sure that these ecological relationships tended to emerge uniformly whenever and wherever plants and groups of plants evolved in company. Ecologists therefore argued that once the necessary fieldwork had been done, it would be possible to treat associations of plants much in the same way that botanists had long treated the many individual plants whose life histories were known to be influenced by factors such as climate and soil chemistry. It would be possible, for example, to manage entire forests as singular ecological entities living in a wild state, instead of selectively cultivating only a few species of trees on biologically impoverished farms and plantations. While working to extend the range and application of their research in this bootstrapping fashion, early ecologists often forgot that they were relying on the analogy of the individual organism as the key to understanding all biological relationships, including numerous relationships that were presumed to be organismal without being located, bizarrely enough, in particular organisms. And so they began to regard their analogies as more reliable than, in fact, they were.

One sees the process of reasoning by analogy at work in a fairly primitive and quite obvious way in a classic paper published in 1887, Stephen A. Forbes's "The Lake as a Microcosm." Self-consciously or not, Forbes borrows the idea of the microcosm from the theater, and applies it to what many ecologists still regard as a clearly defined, relatively easy-to-study natural system. Forbes writes that a small lake "forms a little world within itself—a microcosm within which all the elemental forms are at work and the play of life goes on in full, but on so small a scale as to

bring it easily within the mental grasp." The small lake can be treated as a microcosm because, like the ideal Classical drama, it preserves the Aristotelian unities. "All the elemental forms are at work," Forbes says, on a scale sufficiently small that the life of the lake falls "easily within the mental grasp." He uses yet another term from aesthetics to sum up the advantages of the study of lakes: "Nowhere can one see more clearly illustrated what may be called the *sensibility* of such an organic complex." And he doesn't hesitate to make an "application on a higher plane," or to point up the moral, of "the play of life" in lakes. "Out of these hard conditions, an order has been evolved which is the best conceivable without a total change in the conditions themselves; an equilibrium has been reached and is steadily maintained that actually accomplishes for all the parties involved the greatest good which the circumstances will at all permit."[35]

Forbes favors lakes as objects of ecological study because of the lessons they teach about earthly order. Equilibrium "actually accomplishes for all the parties involved the greatest good," and helps preserve the biotic *demos*. But whether or not the microcosmic expression of sensibility is an adequate concept of what transpires in the theater, it is a vague way to characterize what goes on in a lake, so vague as to be less than useful. The reach of the metaphor of sensibility exceeds the limits of the theatrical analogy's grasp. If we are unmindful of this overreaching, we may begin to take the metaphor, and the analogy, literally, and as the philosopher of science Mary Hesse has argued, by "taking a metaphor literally we turn it into a myth."[36] Any scientific hypothesis that conceals an analogy tends to devolve into a metaphor and to wind up as a myth, at which point it can be said to have come full circle: it has returned to science's point of departure.

It would be easy for us to make a great fuss about ecology's initial dependence on analogy, metaphor, and myth, and to dismiss the work of men like Forbes and Clements as literary rather than scientific in character. Something like this condemnatory approach is the route often taken by radical critics of science, whose assumption seems to be that an idea's cultural origins must determine its destiny (Worster makes the same assumption, but sees it largely as grounds for celebration).[37] However, I think it is more productive, and more properly historical, to understand the development of ecology as a struggle to divest itself of analogical, metaphorical, and mythological thinking, and of literary means of suasion (including narrative). Ecology can then be seen as an ongoing inquiry into the practical value of the analogies proposed by theorists like Forbes, Clements, and others, whose colleagues were willing to point out their errors and to remind them of the crucial differences they had overlooked. On this view, as analogies prove out practically, they in effect become less and less analogical, which means that their discursive origins also become less and less relevant (hence the tendency of historians of ideas and specialists in cultural studies to get things backward, as it were, where science is concerned).

Mary Hesse suggests something like this charitable way of viewing the case in her discussion of scientific models, which she distinguishes from poetic metaphors:

> Poetic metaphors, because they are meant to be ambiguous and thus stimulating to the imagination, are "peculiarly subject to formal contradictoriness," Hesse writes. Scientific models, on the other hand, "may initially be unexpected, but it is not their chief aim to shock; they are meant to be exploited energetically and often in extreme quantitative detail and in quite novel observational domains; they are meant to be initially tightly knit by logical and causal interrelations." And should "models of the same primary system" appear to be "mutually inconsistent, this is not taken," Hesse adds, "to enhance their effectiveness but rather as a challenge to reconcile them by mutual modification or to refute one of them. Thus their truth criteria, although not rigorously formalizable, are at least much clearer than in the case of poetic metaphor."[38]

It must be admitted, however, that Hesse's analysis applies imperfectly to ecology, since she assumes that energetic exploitation of models will ensure continual scientific progress of a sort that ecology has yet to enjoy. Ecological analogies have been persistent largely because they haven't been "initially tightly knit by logical and causal interrelations," as Hesse argues scientific analogies must be in order for them to develop into reliable models. This shortcoming is one that ecologists have had to confront more than once since the days of Forbes and Clements. Frank Golley writes: "Analogical thinking is valuable to establish new hypotheses to follow in research in an area where little is known. It is less valuable when the research plan is clear."[39] In ecology the clarification of research plans has been hampered by the fact that if you scratch them, you tend to find models underneath. Scratch the models, and you come upon a layer of metaphors. Scratch the metaphors, and you discover analogies of the sort that the research plans were supposed to supplant definitely and finally.[40]

Analogies are both an asset and a liability to science, according to the philosopher of science Max Black, who writes:

> The remarkable fact that the same pattern of relationships, the same structure, can be embodied in an endless variety of different media makes a powerful and a dangerous thing of the analogue model. The risks of fallacious inference from inevitable irrelevancies and distortions in the model are now present in aggravated measure. Any would-be scientific use of an analogue model demands independent confirmation. Analogue models furnish plausible hypotheses, not proofs.

Achieving "independent confirmation" of their "analogue models" has been difficult for ecologists to do. Ecological analogies, especially those that have been popularized successfully, have had a remarkable longevity. And they have lacked what Black calls a "capacity for analogical development." This has sometimes made them indistinguishable from metaphors, which operate, according to Black, "largely with *commonplace* implications" that can be teased out by anyone who has "proverbial

knowledge." Black argues that scientific models are more demanding: "The maker of a scientific model must have prior control of a well-knit scientific theory if he is to do more than hang an attractive picture on an algebraic formula. Systematic complexity of the source of the model and capacity for analogical development are of the essence."[41]

It is precisely because Forbes's 1887 article on the lake as a microcosm relies on relatively "commonplace implications" and is uninformed by "a well-knit scientific theory" that those of us who are nonscientists are able to understand it and to profit from reading it. At the same time, there is a substantial body of more recent and much more esoteric ecological theory and research that seems to consist of little more than attempts to "hang an attractive picture on an algebraic formula," despite its being informed by a relatively "well-knit" theory. However, Black does propose a more generous way to view this apparent stalemate, and happily for us, he couches his proposal in ecologically suggestive if not in environmentally appealing terms. "Clearing intellectual jungles," he writes, "is also a respectable occupation. Perhaps every science must start with metaphor and end with algebra; and perhaps without the metaphor there would never have been any algebra."[42] With our equilibrium somewhat restored by this thought, we now are ready to review what might be called the algebraic phase of ecology.

Poking Holes in Wholes

> *Ecology traffics in differential equations, complex statistics, mathematical modeling, and computer simulation. I haven't seen a picture of an animal in the leading journal of evolutionary ecology for years.*
>
> *Stephen Jay Gould,* An Urchin in the Storm

Much of the theoretical confusion of early ecology may have stemmed from an overreliance on analogical reasoning, but it also had its source in holism. Ecologists embraced holism in reaction to the virulent strains of reductionism that, as they saw it, were infecting science, but holism was a poor alternative to reductionism in at least two respects. Methodologically, it was a muddle; philosophically, it derived from dubious sources.[43]

The most determined varieties of ecological holism were probably reflective of personal inclinations, and not the products of careful scientific reasoning. As critics liked to point out, holism had such a strong grip on the imaginations of some ecologists that it led them to overlook the sheer heterogeneity of nature and to underestimate the importance of biological diversity. Critics also liked to point out the lack of agreement among holistic ecologists on a single, unambiguous standard of unity. One ecologist's whole was likely to be another ecologist's part. This led H. A. Gleason, in his 1926 article on "The Individualist Concept of the Plant Association," to argue that concepts of unity having nothing to do with biology were being smuggled into ecology from elsewhere—chiefly, from the hyperactive imaginations of ecologists themselves. As Gleason put it, "Our various theories on the fundamental nature, definition, and classification of associations extend largely beyond the bounds of experiment and observation and represent merely abstract extrapolations of the ecologist's mind."[44]

As a corrective to the unscientific habit of proceeding from an assumption of the wholeness and integrity of plant associations instead of first discovering some evidence that they might actually possess such qualities, Gleason made a daring proposal entirely counter to the sentiments of ecologists like Clements.[45] Gleason asked, "Are we not justified in coming to the general conclusion, far removed from the prevailing opinion, that an association is not an organism, scarcely even a vegetational unit, but merely a coincidence?" He thought the answer to this question must be yes because, as he put it, "every species of plant is a law unto itself."[46] Such being the case, all attempts to construct a typology of plant associations must founder: either the heterogeneity of natural habitats undermines efforts to characterize them as of one sort or another, or natural habitats exhibiting a typical character do so coincidentally. The species living in those habitats have come to be associated with one another more or less by accident, and not as an expression or consequence of a "law of nature."[47] The "typical" character of habitats is not determined by fixed correlations of climate and plant biology, or by succession in the unacceptably teleological sense of the term, but by extremely variable local conditions, including as a leading factor the evolutionary history of individual plant species. As Gleason argued, "Every species of plant is a law unto itself." The apparent orderliness of nature is everywhere transected by vectors if not of anarchy then at least of a stubborn independence amounting to a sort of unruliness. And this means that succession is never a single linear process: its causality is multiple, as are its effects.

The logic of Gleason's argument against holism is impeccable, but holists weren't swayed by it, at least not immediately.[48] Holism would come to be associated even with the ecosystem, a concept originally intended as a corrective to the philosophies of holism and organicism that pervaded ecology in the first third of the twentieth century. A. G. Tansley, a British ecologist, first proposed the concept of the ecosystem in his 1935 paper on "The Use and Abuse of Vegetational Concepts and Terms." Tansley pointed out that the organismal concept of ecological communities was at odds with the standard scientific definition of the term "organism." "The modern biologist," he wrote, "*means* by an organism an individual animal or plant, and would usually refuse to apply the term to anything else. At the most we may be able to get the average biologist to admit that plant (or biotic) communities have *some* of the characters of organisms, and that it may be permissible to apply to them some such term as quasi-organism."[49] In effect, Tansley was urging ecologists to recognize that the organismal concept was only an analogy. It should not guide

research because it tended to color not only the interpretation but also the very gathering of ecological data in the first place. In other words, it created a bias.

Tansley also argued that the plant community isn't the fundamental ecological unit, since many inorganic ecological factors cannot be comprehended if one focuses solely on organic entities (at whatever scale). He meant that ecological research, in order for it to be as comprehensive as it claims to be, must take into account hydrological and geochemical as well as biological phenomena. Tansley wrote: "Though the organisms may claim our primary interest, when we are trying to think fundamentally we cannot separate them from their special environment, with which they form one physical system," the "ecosystem" as he suggested it should be called.[50]

The important point to grasp about this initial formulation of the ecosystem concept is that it doesn't eschew holism entirely. In fact, Tansley's ecosystem concept embraces a wider whole than the organismal concept. But its holism is more formal and less organic than that advocated by Clements and others, and it might be regarded as nothing more than an artifact of the way in which ecosystem ecologists were to organize and conduct their research. The ecosystem is a congeries of organisms and of hydrological and geochemical cycles linked by a number of different mechanisms. Many of these mechanisms are not organic in character, although they do have a tremendous impact on numerous organisms (as when soil erodes, exposing the roots of plants along with the microscopic animals that live among them). So while it greatly broadens the scope of both theory and research, the ecosystem concept also partakes of the reductionism that has come to be seen as one of the hallmarks of modern science.[51] It actually makes ecology more like other scientific disciplines, not less.[52]

The ecosystem was given more formal and, apparently, more precise definition in an influential article published posthumously by Raymond Lindeman in 1942. In "The Trophic-Dynamic Aspect of Ecology," Lindeman defined the ecosystem as "the system composed of physical-chemical-biological processes active within a space-time unit of any magnitude, i.e., the biotic community *plus* its abiotic environment."[53] Armed with this new definition of the functional unit of ecology, ecosystem ecologists from the late 1940s through the 1960s enjoyed a sense of increasing disciplinary power and success, along with increased funding of their research by public agencies.

Perhaps the most prominent of the new ecosystem ecologists was Eugene Odum, a professor at the University of Georgia who helped start the university's field station at the Savannah River Site in South Carolina.[54] Odum authored *Fundamentals of Ecology*, a standard textbook used in many undergraduate ecology classes.[55] He also proselytized for the ecosystem concept, which he interpreted broadly: his published work amply demonstrates his willingness to extend ecological modes of thinking into the provinces of sociology, social policy, and social engineering. At the height of his career, Odum took advantage of the fact that ecology had begun to attract popular interest and was beginning to have political cachet in order to promulgate views that extended well beyond questions having to do with the finer points of ecosystem dynamics.

Odum's willingness to editorialize on such issues as overpopulation and pollution reflected his confidence in modeling as a basic tool of ecological research. Although it may include visual representations at a certain primitive level, modeling should not be understood simply in terms of the creation of ecological look-alikes, as anyone who studies the illustrations in Odum's textbooks and articles, which can be very confusing, soon realizes. Many of these illustrations are elaborate diagrams full of arabesques, which variously represent such arcana as feedback loops, food webs, and the like: it's clear that they are a poor sort of visual shorthand with which to convey some extremely recondite ideas. But in fairness, they are probably meant to do no more than hint at the character of ecological relationships, which are orders of magnitude more complicated than anything that can be captured adequately on the page. Odum's illustrations are best regarded as mnemonic devices and pedagogical aids, and not as "realistic" depictions of the natural world.

Whether this is the light in which Odum regarded the illustrations in his textbooks and articles is open to question, however, since he seems to have been persuaded of the essential validity of modeling as a means of generating an accurate account of the world. Modeling, he wrote, "proceeds logically from pictures to circuit diagrams to mathematical equations." This is taking a sanguine view, but Odum was an optimist. He also suggested that modeling could proceed in the opposite direction, as it were, from reduction of the ecosystem concept to mathematical equations to expansion of it as the basis for an all-encompassing worldview (this would be the ultimate rejoinder to those critics who once dismissed ecology as a mere "point of view" and therefore a pseudoscience). Odum argued that modeling was a wonderfully empowering technique. It made it possible for ecologists to proceed, in a completely rational fashion, from pictures of the ecosystem to pictures of society. "The social science concept of different cultural units functioning together as a whole," Odum wrote, "is, of course, parallel to the ecologist's concept of the 'ecosystem.'"[56] The question to be raised is whether or not this parallelism is only a product of happenstance—of the convergent evolution of intellectual trends, or conversely, of the influence of figures like Herbert Spencer on otherwise divergent schools of thought. If it is only a product of happenstance, then we know what to say to those who argue that descriptions of ecosystems are viable as prescriptions for social change.

That society might be reorganized in accord with ecological principles was in fact a possibility that Odum, like most environmentalists, was eager to entertain. He argued that dynamics similar to those of the ecosystem operated at all levels of life, and he liked to discuss society as if it were structured and functioned like an ecosystem. "The development of ecosystems has many parallels in the developmental biology of organisms," he wrote, "and also in the development of human society." He suggested that a healthy human society, like a healthy ecosystem, would eventually

develop into a "stabilized system" of the type he still referred to as "the *climax*." But Odum also suggested that overpopulation and technological innovation had taken human society beyond the carrying capacity of its environment, to the point where the very character of the earth was being altered for the worse. And he phrased his solution to the human-engendered environmental crisis in the vocabulary of cybernetics: "It is man the geological agent, not so much as man the animal, that is too much under the influence of positive feedback, and, therefore, must be subjected to negative feedback."[57]

The charitable way to interpret "negative feedback" is to assume that it means birth control, which, I believe, is all that Odum had in mind when he used the phrase. His assertion of the necessity of applying negative feedback to "man the geological agent" shouldn't be taken as evidence of his inhumanity. It bespeaks the sense of urgency he felt about the environmental crisis, a sense of urgency widely shared in the 1960s and 70s, a time when many ecologists were led to make doomsday pronouncements they otherwise might not have made.[58] Nevertheless, the phrase "negative feedback" does suggest other, less benign means of reducing human numbers, which underscores the potential dangers of modeling one kind of system on another.[59]

Arguably, Odum's descriptions of ecology as a discipline have a figurative dimension and a Clementsian flavor at odds with his professed allegiance to the ecosystem concept, as when he characterizes ecology in terms of the study of "the gross anatomy and physiology of nature."[60] Odum's explanation of ecological succession, despite being couched in a vocabulary borrowed from physics and cybernetics, also remains essentially Clementsian. It is teleological, holistic, and organismal, and is premised on the reality of the climax. Odum defined ecological succession in terms of three parameters. The first parameter betrays the teleology of his concept of succession: "It is an orderly process of community development that involves changes in species structure and community processes with time; it is reasonably directional and, therefore, predictable." The second betrays its holism: "It results from modification of the physical environment by the community." And the third, its dependence on a belief in the climax: "It culminates in a stabilized ecosystem in which maximum biomass (or high information content) and symbiotic function between organisms are maintained per unit of available energy flow." That "terminal stabilized system," Odum wrote, "is known as the *climax*."[61] Because he tried to preserve the most attractive and inspiring features of the older ecology in combination with the less enchanting and more reductive features of the new (its mundane conception of energy flow and its reduction of biomass to "information content," for example), Odum's work demonstrates how stubbornly persistent analogies can be.[62]

Analogies can inspire modes of thought that don't seem very figurative at all, yet remain so at the core. In the third edition of *Fundamentals of Ecology*, Odum wrote: "The concept of the ecosystem is and should be a broad one, its main function in

ecological thought being to emphasize obligatory relationships, interdependence, and causal relationships, that is, the coupling of components to form functional units." He also described ecosystem ecology as "the formalized approach to holism."[63] Given its basis in biological relationships of interdependence, the ecosystem, Odum thought, was a good candidate for the application of techniques of modeling borrowed from the new science of systems analysis. Using those techniques would help ecologists to preserve their holism intact without lapsing into pseudoscientific speculation.

But Odum's enthusiasm for systems analysis may have been mistaken: it doesn't seem to have translated into ecological practice as smoothly as he thought it would. Robert McIntosh observes that it is hard to tell if systems analysis "is a method, philosophy, or an ideology."[64] Paul Colinvaux is more briskly dismissive of the systems or "information theory" approach, especially when it is applied to so-called food webs. He writes: "The information theory description of a food web sees each individual as a channel at a crossroads through which food freely passes, but real individuals are in fact road-blocks through which food gets with difficulty. It is this fact that makes the model not only unreal, but absurd."[65] In other words, the model fails to treat individual organisms as biological entities: it reduces them to switches in a network, each of which "behaves" in exactly the same way.

Frank Golley, one of Odum's colleagues at the University of Georgia, is unwilling to concede that the systems approach was absurd. But Golley does admit that the rhetoric of ecosystem ecology was always at odds with its practice, and that "successful applied ecosystem work followed the procedures of normal scientific work." That is, "the same process of observation, hypothesis, testing, and interpretation" followed in other biological sciences was also followed by ecosystem ecologists, including Odum himself. Golley notes that regardless of their theoretical claims, ecosystem ecologists still had to "proceed piece by piece, step by step toward a deeper understanding of the mechanisms responsible for an observed pattern."[66]

Even holistic thinkers must put their pants on one leg at a time and first thing in the morning. Such being the case, Worster is probably mistaken when he argues that holism is somehow essential or fundamental to science—to all of science, moreover, and not just to ecology. He writes: "Take away the assumption that the world is an orderly whole whose parts all work together toward a self-regulated stability, that there is an arrangement and coherence to things that can be understood, and science would cease to exist. I now see that science, and every branch of it, had to begin with some holistic ideal. It is a bedrock assumption."[67] Here Worster is once again making a philosophical declaration in the guise of an historical observation. In fact, "the assumption that the world is an orderly whole whose parts all work together toward a self-regulated stability" can be abandoned without its abandonment having any impact on the view "that there is an arrangement and coherence to things that can be understood." We don't need holism and stability in order to have arrangement and coherence. The problem with holism is that we can get along

piecemeal just fine without it, and aren't able to move beyond the piecemeal with it. It is a burdensome ideology.

Yet Worster argues that contemporary ecology, having rejected holism, "has become so imbued with historical consciousness" that it "runs the risk of total relativism."[68] But this is a very strange complaint for a historian to make; and "total relativism" is something the good relativist would have to reject as an empty phrase and a self-contradiction. Perhaps all Worster really means to say is that contemporary ecology has become more relativistic than he likes. If ecology is "the study of patterns in nature, of how those patterns come to be, how they change in space and time, why some are more fragile than others," as another environmental historian, Sharon Kingsland, has suggested, it is hard to see how it can avoid a certain degree of relativism.[69] That, it seems to me, is quite simply the price ecology must pay for its historicism, a historicism with which all of biology, after Darwin, has been saturated.

Given what I've said about it so far, the rise to prominence of ecosystem ecology in the 1960s obviously didn't mean that converts to the ecosystem concept had succeeded in bringing what had been a wayward, ill-defined science under control. The ecosystem concept failed to unify ecology, once and for all, though it did seem sounder than the organismal concept it displaced, which has come to be regarded "as quaint at best, mumbo jumbo at worst."[70] But like their organismal antecedents, ecosystem ecologists also relied on ideas borrowed from other disciplines, especially physics, systems analysis, and cybernetics, none of which have anything directly to do with biology. The "physical or engineering approach to systems," according to Golley, "tended to deemphasize the significance of biological differences." Or, he adds, to cancel it out altogether: "In the ecosystem model, species acted abstractly, like robots."[71] This suggests that ecosystem ecology may have overcompensated for the shortcomings of organismal ecology.

Perhaps the greatest weakness of the ecosystem model is owing to the fact that actual ecosystems "have bewilderingly large numbers of moving parts."[72] "Bewilderingly large numbers" are hard to account for in even the best models, and naturally it is difficult to demonstrate that anything with so many "moving parts" is as coherent and systematic a phenomenon as the ecosystem is supposed to be. "An ecosystem," Ernst Mayr observes, "does not have the integrated unity one expects from a true system."[73] Significant numbers of the living creatures found in any given habitat are likely not to be integral participants in whatever large-scale phenomena may be occurring in their habitat day after day. They are, in effect, antisocial dropouts. The natural historian Sue Hubbell writes: "Individuals within species of the profligate natural world are many, selfish, greedy, pushy, excessive, filling up all available space, taking all the resources to their own advantage, and not all of them may be 'necessary' to the function of an ecosystem. Some may be extras, spare parts, or, to use the currently fashionable word, redundant." But as Hubbell points out, the great difficulty for ecologists lies in determining which species are

the redundant ones and which are vital to the continued health of their habitats: "In our great ignorance of the life histories of even those animals we have identified and named, let alone those we have not, we are a long way from being able to pin the label 'spare part' on any of them."[74] What looks antisocial to one organism may be just another organism's way of biding its time.

So while it is distinctly more robust, in that it embraces inorganic as well as organic environmental factors, the ecosystem concept has one major defect in common with the organismal concept. It does not clearly identify an entity or a process, or a collectivity of entities and a bundle of processes, as the primary object or objects of ecological study. The ecologist R. H. Waring writes: "The ecosystem concept is dimensionally undefined. An ecosystem may be a pond, a catchment basin, or the Earth's biosphere." This lack of dimensional definition is not altogether damning: Waring thinks that the ecosystem concept has been "useful heuristically," and Joel Hagen, who calls it a "flexible abstraction," agrees.[75] But other ecologists and historians of ecology have been less sanguine. McIntosh notes that the ecosystem concept places on scientists trained as biologists the additional burden of becoming competent in aspects of physics, chemistry, geology, meteorology, and other disciplines before they can conduct the difficult interdisciplinary research that the concept entails. Ecosystem ecologists also have to master complicated new instruments that they may not have encountered during their basic training in biology, such as the apparatus of the chemistry lab. "One of the difficulties of following the development of ecosystem ecology," McIntosh writes (making a point also made by Golley), "is to match practice with the rhetoric accompanying the new ecosystem ecology in its several variants."[76] Ecosystem modeling seems to be essentially rhetorical, in that the persuasive power of model ecosystems tends to be more important than the accuracy of their details. And of course even models that do manage to be predictive, and thus seem to be very persuasive indeed, can be misleading. Frank Egerton makes a pertinent point: "As we all know from the history of Ptolemaic models of planetary motion, workable models do not guarantee that one is explaining correctly the phenomena the model describes and predicts."[77]

An even graver difficulty than those associated with modeling has long been a great bother to ecologists. It has to do with quantification. Quantification is essential to modern scientific practice, but obviously it cannot proceed without the prior recognition of entities: scientists have to have something to count before they can generate any data.[78] Unfortunately, as McIntosh points out, ecological entities—plant communities and ecosystems, for example—all too often have been described off the cuff, "on the basis of subjective judgments," without their first having been established definitively as entities by prior biological research.[79] Too many ecologists have tried to identify plant communities and ecosystems merely by getting out of doors and having a look around. They have seen the forest in terms of only a minority of its trees.

Colinvaux argues that what early ecologists "were describing with their elaborate lists" of plants was habitats, and not plant associations or communities. The lists were evidence of the fact that the habitat in which the plants on the lists were found just happened to be hospitable to those particular plants. Like strangers in a bar, they were there at the same, but they weren't really there *together*. Just as skeptics have always insisted, appearances are deceiving. Early ecologists, Colinvaux suggests, were fooled by a trick of the light, as it were, into thinking that they had discovered a pattern in nature when no pattern was there: "Distinct bands of color in a rainbow are an optical illusion, a convenience for memory and expression. The same is true about the belts of vegetation on a mountain; they do not exist as discrete zones of vegetation." It isn't that the tendency some species of plants have of gathering together in association with one another is wholly devoid of biological meaning. It's just that the meaning of such associations is other than was supposed by early ecologists. "Association," Colinvaux admits, "can be a loose form of what biologists call 'symbiosis.'" But symbiosis is comprehensible without making any specifically *ecological* assumptions, and "it encompasses few species rather than many."[80] It doesn't require the sort of large-scale and all-inclusive relationships implied by notions like association or community.

These worries and potential sources of contradiction have sometimes not been recognized at all or dismissed as unimportant by ecologists. Having decided that a forest is of a particular kind, they will set about counting its component species, usually ignoring the great majority of them in the process (since this majority will consist not only of very small plants, bugs, insects, spiders, fungi, seeds, and spores, but of any number of microorganisms as well, some of them incredibly tiny). Then they will massage the data they have gathered into shape. From roughly the 1940s onward, the most popular means of massaging data into shape has been the logistic equation, which when successfully applied generates data graphs with a characteristic *S*-shape. Statisticians seem to find this *S*-shape pleasing, though it is a flattened and rather conjectural *S*, which only emerges after the data points are plotted and then cleaned up a bit by someone with a knowing eye and a practiced hand.

The logistic equation was taught in introductory courses in ecology for many years, but a number of ecologists find its continued use problematic. For one thing, it depends on a prior judgment, often an intuitive one, of the character of a particular object of study, which might be a population of, say, either trees or animals. Data about this population are collected as if the object of study had not been defined in an ad hoc manner ("all the members of species *X* living within the quadrat *ABCD* plotted last week by our research team of first-year graduate students"). Then the logistic equation is applied to this data and depending on the quality of the resultant graphs (depending, that is, on their shapeliness), predictions about the future may or may not be made, and policies set accordingly. Bag limits on deer, game birds, or trout may be raised, lowered, or kept the same, or a forest may be sprayed with insecticide. And if the deer, the game birds, the trout, and the forest are lucky, the extrapolations from raw data made by their managers won't be too far off the mark.

As a research and management tool, the logistic equation has a signal failing, according to Daniel Botkin. Although "the logistic is supposed to be an ecological formula," he observes, "the environment of a population does not appear in it in an explicit way." The environment has been factored out of the equation, quite literally. The logistic can be perniciously reductive: it ignores the random changes to which all organic life is fated, such as, in the case of white-tailed deer and game birds, an unusually heavy crop of mast, or no mast at all, two autumns in a row. In the case of stream-bred trout, the random changes might take the form of an unchecked growth of aquatic vegetation during a mild winter and a resultant banquet of caddis and mayflies come spring; but then again it might take the form of floods and ice jams that scour a streambed and drastically reduce both aquatic vegetation and invertebrate life for a season or two. And in the case of woodland pests like southern pine beetles, the random changes might include genetic mutations making some of the beetles highly resistant to insecticides. The logistic equation ignores both the vagaries of the environment and the genetic variability and adaptability of biological entities, whether they are plants or animals. Botkin writes: "A logistic moose responds instantaneously to changes in the size of the population; there is no history, no time lags, no seasons; a logistic moose has no fat."[81] A logistic moose is therefore no proper sort of moose at all. "One of the major criticisms of mathematical-theoretical approaches in ecology," McIntosh writes, "is that they commonly rest on simplifying assumptions, often unstated, that make them tractable mathematically but nonsense biologically."[82] The charge that they have produced biological nonsense isn't one that ecologists can shrug off lightly.

Applying the logistic equation to ecological problems is appealing because it seems to fulfill the old promise of ecology to deliver something like the whole truth about nature. But to rely on this equation may be to purchase holism at too great a price. Using the logistic equation means treating animal and plant populations as if they were members of mathematical sets rather than members of species, with all the genetic variability membership in a species implies.[83] In the worst-case scenario, applying mathematical techniques to natural populations in order to give one's data about those populations a comprehensible shape means ecology without biology: without genetics and evolution, that is.

The choice between systems analysis and mathematics on the one hand and biology on the other is not a choice many ecologists would want to make in favor of systems analysis and mathematics. Ecologists have had to concede that summing all the parts of an ecosystem, even if it were possible to identify and count them all, doesn't necessarily tell one something meaningful about the whole, however elegant the math involved. They've begun to wonder whether the old maxim about the whole being greater than the sum of its parts is really all that wise a saying.

Summa Ecologica

> *Ecology is not yet ready for its Copernicus or its Kepler, much less its Newton or Einstein . . . because ecology has yet to develop even the consensus about what observations are interesting. . . . We are closer, perhaps, to a lonely priest of Ur, scanning the night skies for patterns and crudely calculating the future course of the heavens, despite gross misconceptions and uncertainties.*
>
> *R. H. Peters,* A Critique for Ecology

Because it faces unusually intense difficulties of self-definition, ecology seems to replicate on a small scale certain features of the broader debate about the unity of the sciences in general. The broader debate assumes the internal coherence of the various scientific disciplines, but in ecology's case, this assumption is unwarranted.[84] Ecology is heterogeneous: there are few ecological concepts that aren't in dispute.[85] As McIntosh suggests, the discipline's heterogeneity reflects the fact that early ecologists were fond of inventing new vocabulary and of defining their terms in an overly imperious fashion. He compares them to Humpty-Dumpty, since like Lewis Carroll's quarrelsome egg they tended to use a word "to mean just what they chose it to mean with little regard for what others said it meant. This tendency," McIntosh adds, "has not disappeared." Idiosyncratic and forceful definition of his terms may have worked for Humpty-Dumpty, but ecologists have found it necessary to pad their own definitions with uncertainty.[86]

Perhaps it is only to be expected that among the most uncertain of ecological terms are those that have been most widely popularized. Consider, for example, the term "niche." The niche is popularly understood to have a spatial reference: in their niches is where the wild things are. For those who believe in the value of finding one's niche, it is heartening to learn that it is "axiomatic that no two species regularly established in a single fauna have precisely the same niche relationships," as Joseph Grinnell observed in his classic 1917 paper on "The Niche-Relationships of the California Thrasher."[87] A niche for every species, then, and every species in its niche: thus the natural order is maintained, and likewise the social, if only metaphorically. Yet for all the apparent tidiness of the concept, and for all its metaphorical appeal, the niche has proved extremely difficult to define with precision.

And yet one might, with equal justification, say that ecologists have defined the concept of the niche to a fare-thee-well, and that the meaning of the word "niche" is in danger of vanishing in a cloud of qualification. Ecological concepts, like all scientific concepts, tend to undergo a process of rarefaction. For ecologists, the word "niche" has lost much of its intuitive sense of spatial location (they borrowed the word from architecture: niches are the nooks in a building in which statues are placed). *Niche* has become, in effect, an esoteric term: it now refers to the *n*-dimensions that a given species utilizes in the full range of its ecological interactions throughout space and time.[88] It is much more difficult nowadays to derive tidy little truisms from the niche, given how ecologists have formalized and refined the concept since Grinnell's day.

However, this seems to be one of those cases in which subtlety and formality have produced not greater precision but increased confusion and unintentionally comic results. According to the ecologists Leslie Real and Simon Levin, the niche "is a central concept of ecology, even though we do not know exactly what it means." Real and Levin report that the equally vague concepts of complexity, diversity, and stability, which also have migrated to the popular discourses of ecology and environmentalism, have generated both semantic confusion and "diametrically opposed results."[89] As Golley explains, "Simple systems may be stable, and species-rich communities may be unstable. No universal pattern holds. Nevertheless, the environmental movement of the late 1960s and 1970s used the diversity-stability hypotheses as a central tenet supporting conservation action, and it is still being taught as a common sense relation." Golley says it is possible that "ecosystems are never stable but are always in a process of change."[90] There is, in fact, some dramatic research suggesting that this is more than a possibility: tropical rainforests are perhaps the most diverse of all terrestrial habitats, and yet they are nowhere near as stable as they once were assumed to be. And one ecologist working in an old-growth forest in Oregon discovered that this forest is unstable, not only over time as he had expected but in space as well. The old-growth forest actually moves: "many of the towering trees have traveled, sprawling root system and all, several feet during their centuries-long lives."[91] Discoveries of this kind have fostered a much more skeptical but at the same time a more open-minded theoretical climate in contemporary ecology.

Colinvaux argues that stability should never have been thought of as an ecological phenomenon in the first place. He writes: "Stability and balance are not so much functions of life acting on life as they are reflections of the underlying stability of physical systems. Perhaps the greatest error recurrent in ecological thought is that which claims stability as a function of biological complexity."[92] In other words ecological stability is a product not of biological forces but of geological and climatic stability. And of course geology and climate only *seem* stable to us because of our limited ability to appreciate the vast amounts of time involved in geological and climatic change, which can have and often does have cataclysmic effects.

Ernst Mayr agrees with Colinvaux that ecological stability cannot be taken at face value, but he is dubious about the concept for a different reason: "No matter how relatively stable a community may seem to be, it actually reflects a balance between extinction and new colonization."[93] Such a balance is, in effect, a statistical artifact. It reflects evolutionary good fortune rather than the healthy diversity of the community, and evolutionary good fortune tends to be quite fleeting if not altogether ephemeral. R. C. Lewontin, a prominent evolutionary scientist and a sharp

critic of flabby thinking in science, argues that "there is nothing in our knowledge of the world to suggest there is any particular balance or harmony. The physical and biological worlds since the beginning of the earth have been in a constant state of flux and change, much of which has been far more drastic than anyone can now conceive." "*The* environment," Lewontin adds, "has never existed and there has never been balance or harmony."[94] Lewontin's approach to ecological concepts is to rarefy them with a vengeance.

Those who believe that ecology has expanded the purview of the sciences have overlooked the fact that a more tough-minded and reductive approach to nature seems to be enjoined upon ecologists sooner or later, and not because nature is simply like that—not because it is atomistic, mechanistic, and deterministic—but because a tough-minded and reductive approach to nature appears to be the most effective one. We have to get on with nature as best we can without succumbing to the allure of all-or-nothing propositions, even if that means sacrificing our hopes for unity on the altar of expediency from time to time. In science, the "diametrically opposed results" described by Real and Levin usually cannot be reconciled, except in very limited and extremely painstaking ways—as they are, for example, in quantum physics. And such reconciliation is not the work of a day; quantum physicists have had to erect a formidable edifice of theory and experiment in order to reconcile seemingly irreconcilable results, and to reduce them to something that only the gifted few and the highly trained can understand.

In ecology, the failure of stability to correlate positively with complexity and diversity, as it once was expected to do, has been a genuine disappointment, since it has made us realize how hard it is to understand complicated, diverse habitats and thus how difficult it is to figure out how to preserve them effectively. I've noticed that such disappointments are rare in the humanities, where contrary "results" or rather interpretations can be reconciled with our expectations with relatively little effort, and I think this is especially true in literary criticism. Literary critics all know how to reconcile incommensurable conclusions about particular objects of attention. It helps tremendously that the majority of these objects of attention—such things as inscription, writing, the work, the text, the intertext, textuality, intertexuality, literature, and "literariness" itself, along with media, genders, cultures, nationalities, and so on, almost *ad infinitum*—tend not to be well-defined and clearly described in the first instance. It also helps that most of these objects of attention cannot be regarded as realities, certainly not in the same way that rainforests and wetlands can be. Taking advantage of the more or less speculative nature of most of the entities that they study, literary critics may treat a colleague's interpretation of one of them as a spirited polemic seeking to change notions about what is acceptable in literary study, and will welcome it as a contribution to the field but without agreeing with it in the least. Failing this sort of canonization by default, another, more ironic sort of canonization—by exasperation, as it were—is still possible. An interpretation may be acknowledged by all parties to be completely and even glaringly wrong-headed

and irresponsible. Yet it nevertheless can be treated as an amusing and instructive "strong misreading," and may become canonical despite, if not because of, its very invalidity.

There is even a sense in which the invalidity of interpretations is essential to literary criticism. The literary affection for metaphor is premised on metaphor's ability to generate "diametrically opposed" readings and incommensurable conclusions. New schools of interpretation are founded, more often than not, when a literary critic makes a few quirky, original assumptions and formulates a novel metaphor (the "homosocial" text is a good recent example; so, for that matter, is the "environmental" text). Never mind that on a first, second, and perhaps even a third inspection these assumptions and this metaphor may seem invalid, and patently so, to those who find it unjustified by textual evidence or unpersuasive on other grounds (e.g., because it's distasteful or too counterintuitive or unhistorical or what have you). This is precisely why wit still plays an important and somewhat nefarious role in literary criticism. That it both tolerates and welcomes misreadings, invalid interpretations, incommensurable conclusions, and just-so stories justifies Ernst Mayr's assertion that literary criticism "has virtually nothing in common with most of the other disciplines of the humanities and even less with science."[95]

Literary critics can agree to disagree happily (I don't mean to imply that they always or even often do). They would welcome Humpty-Dumpty to the fold as one of their own, and give him tenure, too. For ecologists, on the other hand, the fact that "a general synthesis is not currently available at any ecological level" is a cause for deep concern.[96] "Few of the major controversies in ecology, if any, have been decisively settled," according to Mayr, and the unsettled state of the discipline represents something more than just the sort of challenge that young and ambitious scientists are supposed to welcome.[97] It may be a symptom of deep confusion, or still more fundamentally, of outright impossibility.

In his book *A Critique for Ecology*, the ecologist R. H. Peters argues that the theoretical and methodological woes of ecology reflect "the vagueness of ecological constructs." "So much of the science," he writes, "is phrased so ambiguously that the meaning of most constructs is open to reinterpretation by both critic and defendant." Peters has some caustic things to say about ecologists whose work is not directed toward problem solving. He argues that by attempting to synthesize insights from a diversity of scientific fields, such ecologists promulgate tautologies rather than theories. One difference between a tautology and a theory, Peters suggests, is that "a tautology is certain whereas a theory is hypothetical, risky, and dubious."[98] Assumptions about the necessary interrelatedness of all ecological phenomena, or blanket statements like Eugene Odum's assertion that to understand the ecosystem, "the whole as well as the part must be studied," have an *a priori* quality at odds with the empirical character of scientific research.[99] They cannot be tested, since they are not predictive of anything specific. They are platitudes that have yet to be worked up or scaled back into scientific propositions—into hypotheses, that is.[100]

Peters maintains that its preoccupation with model building suggests that ecology has become "a new scholasticism, interminably debating the fine points of unobservables and formalisms." Because the terms on which they rely are not made "operational," which would require that "the range of phenomena that a concept or term represents" be specified, "many influential works in the literature do not contain testable theory, but are only propaganda for developing concepts."[101] Peters explores the flaws of a wide range of ecological concepts in his book, and much of what he has to say about them is surprisingly harsh.[102]

Consider what Peters says about the concept of *environment*, quite possibly the most popular and (therefore) the most mystified ecological concept of all. Its "vagueness," he notes, "has long been recognized by ecologists." *Environment*, Peters argues, is a nonconcept, a word without a definition and lacking a referent. In ecological practice, the environment can be defined only by "stipulating what it is not." Peters writes: "The environment is that which is not the object of investigation. Thus the environment of an entity is everything outside that entity. This sweeping definition of environment introduces a number of operational difficulties." These operational difficulties include the problem of determining where the boundary between the inside and the outside of a given entity is located. This problem will be less easily resolved for some entities than for others, and it is exacerbated by considerations of scale. Many microorganisms have permeable cell membranes and thus have extremely fluid physiological boundaries. Their relationships with things "outside" them tend to be ambient in a way that makes models based on exchanges between internal organs and the external environment less than perfectly applicable to them. Microorganisms are, in a very real and specific sense, always a part of the environment they inhabit and are "at one" with it. They are less like switches in a circuit than they are like free-floating filters that have come loose from their fittings. Using the term *environment* thus introduces a high degree of relativity and ambiguity into ecological research. Peters argues that the same can be said of related terms like *habitat* and *ecosystem*.[103] Of course many ecologists still use these terms, but fewer and fewer of them assume that when they use them they are designating specific entities. This is perhaps the chief reason the concepts attached to these terms seem less viable than they used to.

Peters has little patience for the attempts made by some ecologists to salvage vague concepts for the sake of their heuristic value. He insists that ecological theories need to be predictive, and explains that this doesn't mean that they need to be *true*: "Scientists are never entitled to conclude that successful theories are true. They can only make the modest claim that the theories which worked in the past are more likely to do so in the future than theories which failed in the past."[104] If Peters is correct, we shouldn't go seeking for the truth *of ecology* without first taking into account the limited role of truth *in ecology*.

Peters insists (and ecocriticitics who want to restore representational art to its former glory ought to take notice) that the goal of ecology, especially at a time of global

environmental crisis, should not be to generate a correct picture, complete in all its details, of the workings of ecosystems, but to explore ways in which particular environmental problems can be more effectively addressed and redressed. Aside from the urgency of solving these problems, Peters argues that the more theoretical approach to ecology, while it may be more alluring intellectually, has not been very compelling otherwise: "Ecology compounds its single failings. Operational impossibilities spawn tautological discussions that replace predictive theories with historical explanations, testable hypotheses with the infinite research of mechanistic analysis, and clear goals for prediction with vague models of reality."[105] Ecology could use better techniques and methodologies, and an epistemological housecleaning, too. And it was ever thus: in ecology, the need to put Humpty-Dumpty together again, like the need to define his terms, has been perennial.[106]

One might argue that the fault of many ecological theories is their immodesty, the way in which their explanatory reach consistently exceeds the grasp of research and experiment. Such excess is usually what we mean, after all, when we use the term *heuristic* to justify our use of vague ideas. To be heuristic is to jump-start an interpretation by making a few convenient but otherwise unwarranted assumptions (as when psychoanalysts assume that the unconscious is structured and functions like a language). "'Explanatory' concepts and theories that satisfy a widely felt need for plausible, causal descriptions of nature," Peters writes, "hide the shortcomings of our theories under prose that explains away rather than explains." Ecological theory "must be judged on the evidence," he insists, and not on the "plausibility of the prose in which it is couched."[107]

One source of the plausibility of ecological prose has been the seductiveness of the analogies on which many ecological theories have been founded. Consider the analogy of the "web of life," which has become one of the pet notions of environmentalism and popular ecology. Several generations of ecologists found the idea that "every phenomenon sits in a web of interacting, multiple factors" an appealing way to characterize ecosystem dynamics, but the idea hasn't been a fruitful one. "Attempts to describe this web," Peters notes, "lead one back to a mechanistic approach to ecology and to an infinite research program." That is, one becomes preoccupied with discovering and describing the various interstices of the web in the absence of any concrete evidence of the existence of the web as a whole, and still worse, in the absence of any concrete evidence that the web *is* a whole. Peters concludes that because they tend to encourage unfocused research of this sort, "analogies are too undependable to serve as theories."[108] They keep returning ecology to somewhere very near square one.[109]

Another marker of the boundary between the humanities and the sciences is the disparity in the relative weight each assigns to similarity and difference, and hence to analogy, in constructing their accounts of the world. Historians—particularly historians of ideas, which tend to be extremely plastic—may be led to treat similarity as more vital than difference by the hardships that arise whenever one tries to

forge a coherent narrative. In a coherent narrative, similarity takes shape in the form of repetition: something early is judged by the narrator to be analogous to something late, and by focusing on this analogy a vast amount of time can be tamed and history brought to heel.

Literary critics favor similarity over difference with even greater zeal than historians, perhaps because they write with fewer constraints on the claims they allow themselves to make. Playing hunches, despite the inroads of theory, still seems to be essential to literary criticism as practiced, if not quite as professed. As practiced, literary criticism remains more or less intuitive. Thus literary critics are twice removed from science, and are likely to have a correspondingly impaired sense of difference. By virtue of their training, a point of view is all the Archimedean equipment literary critics need in order to interpret the world, including the natural world, which some of them regard as a text that they, too, are qualified to read.

Because scientists cannot overlook the difference between texts and the natural world without causing outbreaks of contagious disease, uncontrolled genetic mutations, catastrophic climate change, mass extinctions, and loss of their funding, they have to learn how to use analogies with rigor and precision, if use them they must. They also have to learn how not to confuse analogies with metaphors. In literary criticism, rigor and precision play a much less prominent role, and the distinction between analogy and metaphor is frequently ignored. Arguably, this is a serious dereliction of professional duty, since attending to the workings of rhetorical figures is something a literary critic is supposed to do *ex officio*.

One consequence of ignoring the distinction between analogy and metaphor in ecocriticism has been a gross misunderstanding of ecology, in which analogy has played a central but controversial role, and a correspondingly gross overestimation of the nearness of ecological thinking to poetic and other modes of essentially comparative thought. But it may be the peculiar fate of analogies, no matter who handles them, to become metaphors and when imaginations run amok, as they are prone to do, symbols. An analogy may begin as an illuminating comparison in which the differences between terms are preserved and clearly understood even if not explicitly stated, and end up as a metaphor, or an obfuscating equation in which the differences between terms have disappeared completely. If the new metaphor is allowed to stand, the emotional appeal of the vehicle will displace the tenor almost entirely, ultimately resulting in a symbol open to the most disparate interpretations. And all this can happen even when the original analogy is a dry one that would seem to have very little symbolic promise—as when the ecosystem concept, with its borrowings from cybernetics, is taken to imply a mysterious interconnection of one and all. Of course, some ecocritics have complained that discovering mysterious interconnections by way of analogy, metaphor, and symbol is simply what poets do, and they blame literary theory for trying to debar such discoveries. However, literary theory is an attempt to check not poetic but critical license.

Patchwork

> *How have we come to believe things about nature that are so untrue?*
>
> *Stephen Budiansky,* Nature's Keepers

In order to comprehend the intellectual difficulties that ecologists face, it helps to consider the history of their discipline not in philosophical context, as a reaction against reduction and in favor of holism, but in the context of the development of the theory of Darwinian evolution. Much of what has passed for ecological theory has been at odds with Darwin's insight into the role of natural selection in evolution.[110] This conflict is one I've hinted at before, and it tends to arise whenever ecologists try to extend their understanding of the natural world much beyond the life history of a single species or small groups of closely related species. But to say this may be to say that ecologists run afoul of Darwin just as soon as they set up shop, because the very notion of the ecological seems to be at odds with Darwinian theory. "A commitment to the evolutionary world view," Richard Levins and R. C. Lewontin write, "is a commitment to a belief in the instability and constant motion of systems in the past, present, and future; such motion is assumed to be their essential characteristic."[111] As I've tried to show, ecology has had a difficult time comprehending phenomena like instability and constant motion.

To pursue an ecological line of research, as classically described by theorists like Frederic Clements, may be to court every step of the way a contradiction of Darwin and, after the so-called and highly successful modern synthesis of the Darwinian theory of natural selection and the Mendelian theory of inheritance, of the demonstrated facts of genetics as well. For this reason, the schools of thought known as "population ecology" and "conservation biology" are now two of the more vital of ecological subdisciplines, not coincidentally because of their Darwinian perspective on ecological phenomena, a phrase that would have struck Frederick Clements and his peers as oxymoronic.[112] Stephen Jay Gould explains that population ecology embraces "the central Darwinian postulate that nature manifests no higher principle than the struggle of individual organisms to maximize their own reproductive success. Notions of community and natural harmony, however illuminating as metaphors, do not reflect nature's primary evolutionary unit, the population of individuals within a species."[113]

Ecology in the traditional sense of the term still popular with environmentalists and ecocritics, ecology that seeks to demonstrate the reality of plant and animal communities and of natural harmony, is hamstrung by its inability to pursue its goals using the most effective tools of biological research. Historically, ecology has had a pronounced tendency to leave the realm of biology altogether, in pursuit of somewhat ethereal if not entirely metaphysical entities. The inherent tensions of ecological thought are neatly demonstrated in Colinvaux's discussion of the ecosys-

tem concept, which he calls "an idea, a people-made thing" and "a way of looking at nature. It is an admission that there is no super-organismic thing out there made by some masterly designer. There are only Darwinian species."[114] On this account, the ecosystem concept is only a way of organizing one's thinking about groups of species that one otherwise treats as individuals. If so, then *ecology* is a catchall term used to describe a science more diverse in theory and method, and more free-wheeling and unconstrained, but less finely tuned and less productive of definitive results than microbiology or physics, and we seem to be right back where we started. Ecology is just a "point of view."

Yet despite what I have reported so far, and despite some of the more polemical points that I have made or have quoted others making, critics like Colinvaux, Peters, McIntosh, Egerton, Mayr, and Botkin aren't entirely negative about ecology's prospects. After all, they are ecologists themselves. Each of them suggests that ecology has certain strengths, even if it doesn't exist in a state of grace or a definite form, but has fragmented into a variety of closely allied subdisciplines. The things that ecology does well tend to involve areas of applied science like forest, wildlife, and fisheries management, or the restoration of degraded habitats to something approximating a pristine state (even if that pristine state is, for historical reasons, more or less conjectural). Ecology's success stories have grown out of research projects of relatively modest scope, the results of which have shown a gratifying tendency to rebound upon the formulation of theory, correcting, adjusting, and reshaping it in positive ways.

The fact of the matter is that ecological research is extremely difficult. The grand sweep of many ecological theories is a response to the vastness and complexity of nature: comprehending this vastness and complexity on an appropriate scale and in meaningful detail is hard to do well, assuming that it can be done at all. The intellectual and methodological challenges of ecology are further compounded by a host of very basic technical problems. Ecologists cannot take comfort from and refuge in a well-equipped laboratory purchased right off the shelf and marked "for the use of ecologists only." They often have to improvise on the spot. And in any case, it is entirely possible that the laboratory's artificiality "may simply swamp processes of ecological relevance," as Peters has suggested.[115] The laboratory tends to cancel out the very factors that we think of as ecological.

As if all this weren't handicap enough, fieldwork, which appears to be the bread and butter of ecology, can be just as problematic as lab work. The quadrat method, in which a researcher stakes out plots of a standard size in a given habitat in order to study, say, the patterns of succession of native versus alien plants or the foraging habits of feral hogs, may be invalidated by the patchiness of that habitat, particularly if an awareness of this patchiness isn't accounted for theoretically and designed into the research beforehand. But this, too, is a difficult thing to do, since patchiness and the quadrat method are inherently hard to reconcile. An environment—*any* environment, though some more than others—is patchy because plants and animals

aren't distributed in it evenly, but in a randomly variable (or *stochastic*) fashion. To risk an analogy, one bite of an apple may not have a worm in it and another bite may, but no prediction of the outcome of any one bite is possible since the distribution of worms in apples is wholly unpredictable (let us assume). Caution is advised when we bite apples, but it won't ensure that we never bite any worms inadvertently.

By the same token, habitats vary, and not just over time, as we have long realized (we call that realization "geology"). Habitats also vary from point to point and place to place; they differ, not only one from another, but internally as well. In a sense, what patchiness really means is that the idea that habitats are composed as all-encompassing "environments" is false. Patchiness, random variation, pattern, or grain—ecologists use these words interchangeably, but call it what you will, patchiness frustrates our attempts to identify and understand natural systems as, well, natural *systems*.[116] It threatens to reduce ecological research to patchwork. The irony, however, is that reducing ecology to patchwork may strengthen its claim to scientific validity in the eyes of its critics.[117] Ecology falters; its subdisciplines, all of them in varying degrees heretical, thrive.

Patchiness has made a very strong impression on contemporary ecologists, and they have begun to characterize ecosystems in a much less idealized and more neutral fashion than they used to do, in large part because they now recognize that random change is "intrinsic and natural at many scales of time and space in the biosphere," according to Botkin. To some extent, this new view of nature as prone to disturbance owes something to a general change in the scientific temperament over the last century. Chaotic phenomena like turbulence now seem much more attractive and interesting to us than they did in the past, and no longer figure in the scientific imagination as something to be explained away so that our sense of an orderly universe can be preserved. Once physicists became aware of quantum phenomena, the order of nature began to be regarded as a much more open question in general, as Botkin points out: "The profound philosophical arguments that arose from the development of quantum theory in the 1920s opened up the possibility of a very different perception of the physical universe: the universe as fundamentally stochastic to some degree."[118] Of course, one could argue that if ecology has become more like other sciences than it used to be, it is partly because other sciences have become less positivistic—and hence more like biology—than they used to be.

In recent decades, the elaboration of chaos theory has been of particular importance both for ecology and in it. The theory hasn't been imported wholesale from other disciplines, as systems analysis was, but is something to which ecologists have made original contributions. This doesn't mean, however, that ecologists now feel stymied by a world at last admitted to be fundamentally indeterminate and wholly chaotic, and that they have conceded the main point to the harshest, most antinomian critics of science. That the world is fundamentally indeterminate and wholly chaotic, a swirling vortex of sheer disorder from which order only arises provisionally—that the appearance of order is only an illusion—isn't what chaos theory ar-

gues.[119] And yet the fact that ecologists have embraced a less determinate view of nature does mean that they have had to distance themselves from the rosier varieties of environmental thought, to resist their own positivistic impulses, and to refrain from open-ended theoretical speculation, or at the least to speculate more parsimoniously than they once did.

After more than one hundred years of research, ecology is not yet a fully mature science, but is still discovering its subject matter and elaborating its key concepts and basic methods. Golley's wistful description of ecosystem ecology in the mid-1960s still resonates, and might be applied with some justice to the discipline as a whole today. He writes: "The condition of ecosystem studies at this time might be characterized by Claude Levi-Strauss's term *bricolage*, which refers to the construction of an object or a theory from a variety of unrelated, found materials. The *bricoleur* arranges these and creates something new and unexpected from the disparate materials."[120] Ecology continues to be a makeshift affair. No doubt this is precisely why it seems attractive to the kind of scientist who enjoys poking around outdoors and tinkering with things to see how they work.

Disturbing Nature

> *In most ecosystems the interval between disturbances—fire, frost, flood, windstorm—is almost always less than the life span of an individual member of the dominant species. So much for balance.*
>
> *Stephen Budiansky,* Nature's Keepers

In his 1899 article on "The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan," Henry Chandler Cowles seems to anticipate the theoretical bashfulness and cautiousness of many present-day ecologists when he discusses the patchiness of plant societies and notes that ecological terms are semantically ample for good reason. Cowles writes: "The term patch or zone has a value like that of variety in taxonomy. Authors disagree, here as everywhere, upon the content and values of the terms employed; this disagreement is but an expression of the fact that there are few if any sharp lines in nature." He adds that in field biology, terminology "is largely arbitrary and adopted merely as a matter of convenience." The question a contemporary ecologist must ask, however, and must ask more forcefully than Cowles could have done, is how much convenience there is in terminology as arbitrary as some ecological terminology seems to be. A contemporary ecologist would have to note that the homely comparison Cowles makes of the sand dune complex to "a river with its side currents and eddies at many points, but with the main current in one direction" is no longer a comforting thought, in light of the things we have learned about the chaotic nature of the turbulence that accompanies a river's

"main current in one direction."[121] Are the phenomena of ecological interest out in the channel with the unidirectional flow of the main current, or are they tucked away in the contrary side currents and whirling eddies? Or are they to be discovered in the complex interaction of the river's many and braided currents with the surrounding geography of its watershed as a whole, shaped as that watershed has been by the larger forces of nature, and perhaps by human hands as well?

These seem to be increasingly difficult questions to answer, even as their urgency grows. The environmental crisis is frustratingly manifold. "We are hybridizing the planet," the science writer Jonathan Weiner warns. "We may be creating conditions in which evolution is running at its maximum rate." Insects reproduce so often that our use of insecticides has acted on them as a novel form of selection pressure. In a number of cases, this has had the effect of improving the breed, so to speak, in a very short time. According to Weiner, "every postmodern, well-equipped house fly" is now the bearer of a "mutant gene" making it immune to pesticides by limiting its uptake of them from the environment. The creation of postmodern insect pests reflects the perverse dynamics of our treatment of nature: "We bring strangers together to make strange bedfellows, and we remake the beds they lie in, all at once."[122]

But Weiner's point about human hybridization of the natural environment may be made in too dramatic a fashion, at least in one respect. Far from being solely a postmodern phenomenon, hybridization is nothing new. "The man with the axe is an integral part of nature," the natural historian Marston Bates once observed, "and the consequences of his activities make an interesting and important, though dismal, field of study."[123] The man with the ax is not a wholly different figure from the man with the insecticide sprayer strapped to his back or hitched to the rear of his tractor. Both men are engaged in a process of rearrangement, restructuring, and redefinition of the natural world and the creatures in it.

An awareness of the long-term human manipulation of the environment ought to be fundamental to ecology, Stephen Budiansky argues: "After ten thousand years of breaking the soil, after a hundred thousand years of setting fire to the forests and the plains, after a million years of chasing game, human influence is woven through even what to our eyes are the most pristine landscapes." He suggests that ecologists have done a poor job of taking into account the less than pristine condition of nature. In fact, the central claim of Budiansky's book *Nature's Keepers* is that ecologists have been charmed, just like the rest of us, by the idea of an Edenic natural world. "The entire modern conception of nature," he writes, "depends upon denying her checkered past." Realizing that this has been the case for too long, some restoration ecologists have set about their work in a new way in recent years, taking into greater account than they used to the long-term human presence in and its effects upon the landscapes they attempt to restore. "The artificial," Budiansky suggests, "is more natural than the natural."[124] Humans play a central role, for example, in the ecology of fire: many habitats long thought to be entirely natural are now recognized as the products of deliberate and not always carefully controlled fires set by humans. Fire,

in other words, can be an important management tool (albeit one that needs to wielded very carefully nowadays, considering the density of human populations in or near many tracts of otherwise wild land and the buildup of immense stockpiles of fuel thanks to the longstanding practice of fire suppression by forestry and other agencies).

Budiansky's arguments derive in part from the school of thought known as "the ecology of natural disturbance." But he is impatient with academic ecology ("a perusal of the present-day scientific literature in ecology reveals an almost neurotic degree of guilt and self-doubt"), despite his enthusiasm for many of the conclusions reached by the revisionist thinking characteristic of the discipline since the early 1970s. What Budiansky does admire is the hands-on attempts of restoration ecologists and managers of wild lands less interested in refinements of theory than in repair and maintenance of damaged habitats: "Restoration experiments are a way to figure out how natural ecosystems work; they are also a way to figure out what went wrong in natural systems that are no longer working properly."[125] Some of these experiments involve nothing more elaborate than conducting controlled burns, and then waiting to see what happens next.

Given the alarming situation described by Weiner, and the undermining of what long has been thought to be ecological wisdom and the subsequent faltering of the discipline described by Budiansky, it is no wonder that a critically engaged ecologist like R. H. Peters should make the claim that "the problems that ecology should solve are not being solved. They are worsening, growing more imminent, more monstrous."[126] Yet very little of the anxiety of ecologists over the travails of their discipline has been communicated to the wider audience interested in ecology and in environmental issues. Many members of this audience still engage in freewheeling speculation of the sort ecologists are now trying to avoid, though not always successfully: "Armchair, and bar stool, ecology continues to be alive and well, despite its bad press."[127]

In the next two chapters, I will discuss the armchair and (for all I know) barstool views of ecology held by those who, for political reasons, are suspicious of science, and conversely, the views of ecology held by those who, for aesthetic reasons, are charmed by what they regard as its scientific sanction, its truth. Neither party seems to realize how keenly aware ecologists are of the shortcomings of their own work. Those who are wary of ecology simply because it is a science do not realize how much intense scrutiny the field has given its own imperfections, but then they are too suspicious to give the testimony of scientists the benefit of doubt. Those who celebrate ecology as a latter-day revelation of truth do not recognize its shortcomings, either, because they put too much trust in what the bumper stickers say. They also fail to give the testimony of scientists the benefit to be had from doubt, preferring instead to take the truth of ecology for granted.

EPILOGUE

A Word for Wildness

Where was it one first heard of the truth? The the.
Wallace Stevens, "The Man on the Dump"

There are at least two reasons that the several attempts to define ecocriticism as a practice that I have reviewed in this book have been less than convincing, if not wholly unconvincing. The first has to do with the fact that these attempts have been premised on the assumption that practice can be conducted in opposition, as it were, to theory, and even as a rebuke and a corrective to it; and the second, with the fact that ecocriticism does not "face an organized structure," as the sciences generally do, at least according to Karl Popper, "but rather something resembling a heap of ruins (though perhaps with treasure buried underneath)."[1] I should add that reason two is very closely related to reason one—so much so that to me it seems to be the very crux of the matter. I think it is precisely because ecocriticism finds itself in the position described by Popper than it can ill afford to reject theory, not only if wants to seem coherent, or both practicable and practical, as a variety of literary criticism, but also if it wants to make good on its claim to be interdisciplinary.

For ecocriticism to earn its spurs intellectually, it must acquire not only more theoretical savvy but a less devotional attitude toward its subject matter, both literary and otherwise, as well. Certainly defining ecocriticism and its objects of study in terms of a revival of realism and of long-established literary modes like the pastoral, and more broadly in terms of the dictates of human cultural evolution and ecological science, restricts the interpretive options available to ecocritics much too severely, and may even render their interpretations unintelligible. Those who have offered restrictive definitions of ecocriticism have tended to overlook both the limited appeal and the ambiguities of the literature that can be accurately described as realist or pastoral, while subscribing to mistaken notions about the human place in nature (or the lack thereof) and the current state of ecological research. The result is that ecocritical celebrations of so-called environmental literature—of nature poetry, nature writing, and what have you—have rung hollow much of the time.

Personally, I think ecocriticism ought to be more offensive than it has been. I mean that ecocriticism ought to quit being defensive, so that it can take the initiative

and state its case without trying to trump what it imagines to be its enemies ("metropolitan" academic elites and the literary theory they adore), and without making claims that it cannot substantiate with solid evidence and sound argument. But I also mean that ecocriticism ought to be less devoted to pieties: that it ought to offend. Joseph Meeker's celebration of the picaresque as a model of environmental literature is problematic, given the realities of literary history and the perennially confused state of genre conventions and definitions of modes, especially where fiction is concerned. Nonetheless, I think the ecocritic would do well to emulate the picaro's mobility and fluid, playful sensibility. Like the picaro, we have to find our environmental sustenance as best we can, whenever and wherever it is to be found. Nor can we afford to be moralistic. An offensive and picaresque ecocritic will be less like a watchdog policing the boundaries of the wild and more like a coyote expanding the territories of the wild opportunistically and wherever it roams. The ecocritic-as-picaro will be much less attracted to prophecy, and will make judgments that, though they may seem expedient—and even offensive—to some, will be a lot more expeditious than ecocritical judgments currently are. Offensive and picaresque ecocritics will be engaging something more than an imaginary earth because they will be more imaginatively engaged with the earth as it is, urban wastelands, wildernesses, and all.

A passage from one of Wittgenstein's notebooks suggests a model of how picaresque ecocriticism might conduct itself offensively in relation to the institution of literary criticism as a whole. Wittgenstein asks, "What is it like for people not to have the same sense of humour? They do not react properly to each other. It's as though there were a custom amongst certain people for one person to throw another a ball which he is supposed to catch and throw back; but some people, instead of throwing it back, put it in their pocket." "Or what is it like," he continues, "for somebody to be unable to fathom someone else's taste?"[2] Anyone familiar with Wittgenstein's writing will recall how often he puts the ball in his pocket when he plays the language game called philosophy. He doesn't do that simply because it suits his humor or because he is perverse; he does it as a way of making a point about how the game of language might be played differently by philosophers, once they recognize its almost purely conventional nature—once they realize that philosophy itself is structured like a game, as the saying goes.

Flouting philosophical convention was Wittgenstein's way of imagining and inventing new games, and of liberating thought. Naturally, there were those who could not understand what he was about, and they were quick to accuse him of not playing ball. They thought his writing was impertinent and erroneous, or simply irrelevant; some even accused him of incivility—of seeking to offend. Certainly Wittgenstein was unwilling to philosophize in the usual fashion, but that, I think, was merely a reflection of his peculiar competence.

Without recognizing it, ecocritics are in somewhat the same position with regard to literary criticism as it is usually practiced that Wittgenstein was in with regard to philosophy as it was usually practiced in his day. They want to play ball

using that spherical object we call the earth, but without recognizing the necessity to invent new approaches to the game of literary criticism. They continue to pitch upon the familiar turf of pastoral poetry and nature writing, and have been caught in a squeeze play by the superannuated issues of organic form and the referential function of language, which they might have avoided if they had conceived of their task differently. I think a little incivility will serve ecocriticism well, even if its only effect is a change of tone. I have a hunch, however, that the consequences of adopting a critical strategy of incivility will be richer than that because ecocriticism will be brought more into line with what is recommended in the most daring moments of the very literature its practitioners profess to admire. I have in mind, first of all, the breathtaking rupture of civility announced at the beginning of Thoreau's essay "Walking." He writes:

> I wish to speak a word for Nature, for absolute freedom and wildness, as contrasted with a freedom and culture merely civil,—to regard man as an inhabitant, or a part and parcel of Nature, rather than as a member of society. I wish to make an extreme statement, if so I may make an emphatic one, for there are enough champions of civilization: the minister and the school committee and every one of you will take care of that.[3]

Some readers of "Walking" wax sentimental about the saintly figure of the saunterer that Thoreau goes on to celebrate in the body of his essay. He interprets the word "saunterer" as a double-barreled pun on the French *Sainte-Terrer*, one who goes to the holy land, and on *sans terre*, without land or home or property of any kind, and therefore not guilty of the theft that all property is said to be. A *saunterer* is a *Sainte-Terrer* who is also *sans terre*, and is therefore the embodiment of all the Thoreauvian virtues.

However appealing the figure of the saunterer may be, I don't think one can afford to ignore the abrasive quality of Thoreau's pun; he offends not only against etymology (his is fanciful, and mistaken) but also against his propertied audience.[4] None of its members, Thoreau implies, can be saunterers because they are the sort of vagrants who spend their days sitting "still in a house all the time" and worrying about church and state.[5] For Thoreau as for Wittgenstein, puns are a way of rewriting social contracts, specifically those concerning language and its rightful uses, and of thumbing one's nose at established meanings and values. The Thoreauvian saunterer may therefore be a more picaresque and less saintly figure than is generally recognized.

When I disparage ecocriticism for adhering to standards that are "merely civil," I have in mind both the high moment that begins "Walking" and the outlaw impulse that informs much of the literature of wildness published in the wake of Thoreau's essay. However, I think it's best not to be too literal-minded about what constitutes wildness. Consider, for example, A. R. Ammons's book-length poem

Garbage, which seems to me to be a much more wayward text than most of the others that might be rounded up and gathered under the rubric of wildness (the essays and fiction of Edward Abbey come immediately to mind: wild, yes, but utterly predictable, too). Since Ammons's poem was published in 1993 and is in every sense of the term a contemporary work, a look at *Garbage* will help refresh and revise our sense of what wildness can mean.

Ammons is (or rather, was; he died in 2001) a very sophisticated jokester, if not a trickster, and although he has been celebrated for his contributions to nature poetry, I imagine that *Garbage* sticks in the craws of more than a few of his fans. There is the poem's in-your-face title, to begin with; then there is the fact that the poem isn't much like Ammons's shorter and more intensely lyric poems, especially those from early in his career, which display all the belletristic virtues: they are dense with beautiful imagery and language, and are very tightly focused both thematically and intellectually. *Garbage* also has, to be sure, considerable verbal charms, and it isn't lacking in intellectual high moments, either. But much of the poem is avuncular, goofy, and rambling, like an old man talking to himself, while other parts of the poem are deliberately lowdown and impious, even salacious, also like an old man talking to himself. What remains is often steeped in reminiscence, some of it pleasantly sentimental, some of it painful and death-haunted: again, like an old man talking to himself. The fact that it is the same old man talking to himself throughout the poem gives *Garbage* its quality of wildness: its voice is that of someone who is not only comfortable speaking without bounds (as Thoreau might say), but is delighted to be able to do so. I should mention that the poem is set, for the most part, in a garbage dump: Ammons was inspired to write *Garbage* by the sight of a mountain of trash towering over a landfill located near Interstate 95 in south Florida. He is an incurable romantic of an unprecedented sort, one who takes his "mountain gloom and mountain glory" just as he finds it, and wherever he can find it.[6] For Ammons the alpine is a point of view: it doesn't have to be a place.[7]

Rhetorically Ammons might be said to have two modes, a Stevens mode and a Whitman mode, and in *Garbage* (as in his other long poems) the two modes constantly interface, interact, and interpenetrate. Their endless combinations and recombinations give rise to permutations enabling Ammons to insist (and I think Barry Lopez should take note) that "garbage is spiritual" and that the garbage dump is "where the consummations gather," while never losing sight of the fact that his metaphors are metaphors, that "spiritual" garbage is still garbage, "false matter, hamburger meat left out."[8] In other words, if garbage provides Ammons with a Whitmanesque catalog of the flotsam and jetsam of consumer culture (broken lawn chairs and lemon crates, worn-out baby strollers, partially eaten hot dogs, spoilt ground beef, and the like), it also provides him with a Stevensian idea of order, because the garbage dump, far from being, as it was for many of the modernists, an emblematic wasteland, is for both Stevens and Ammons the ideal locus for contem-

plating the creative nexus where culture and nature commingle and consummate their relationship.

In his poem "The Man on the Dump," Steven insists that "the dump is full of images." Ammons agrees, and for him as for his predecessor, the dump is metropolitan and pastoral, civil and uncivil, a monument to the folly of consumption and one of the high temples of consummation. It is an uncanny place where, along with Stevens, one might fittingly "murmur *aptest eve*."[9] In the garbage dump, one set of qualities is composted back into the other, and culture becomes natural again, not by means of an epiphany but through more reliable and much less visionary processes. Consumption, consummation, and recycling, whether of garbage or of poems like "The Man on the Dump," seem to be inevitable, whether we attend to them or not; Ammons thinks we might as well attend to them.[10]

Thoreau's strategy was to speak on behalf of wildness from the wilderness: figuratively from Walden Pond, and actually from the Maine woods. Thoreau wasn't lacking in sassiness, as many a passage of *Walden* and of *The Maine Woods* demonstrates, but Ammons's strategy is much more rebarbative: he speaks on behalf of wildness from a landfill. Doing so enables him to capture more of the figurative and actual truth about culture and nature, and about what we desire and what we do not. The garbage dump may be filled with "permanent waste," 2 percent of which is "disposable diapers, good to last / five hundred years: cute little babies' shit," and these would seem to be depressing figures, both numerical and poetic.[11] Yet Ammons likes these figures because they establish the garbage dump's importance as a reflection and, indeed, a repository of culture. Our most enduring monuments commemorating our presence on earth are likely to be the markers we don't really intend to leave behind, our by-products, which are "disposable" in only an approximate and relative sense of the term. Not every "heap of ruins," to recall Popper's words, is going to have "treasured buried underneath" it. Even so, Ammons finds reason to be light-hearted: from the costive perspective of an old man forced to dose himself with soy laxatives, babies' shit really is cute. It may even be a subject fit for Whitmanesque celebration.

The garbage dump's accidental, unintended status as a cultural monument—and the fact that it's full of slowly moldering junk—doesn't mean that it can't be a positive model of art, which very obviously isn't something that Ammons thinks of solely in terms of the fashioning of priceless treasures (even if he is a poet who likes to compose at the typewriter, toting up his words on fat rolls of adding machine tape). He writes:

> I punched
>
> out Garbage at the library and four titles
> swept the screen, only one, Garbage Feed,
>
> seeming worth going on to; and that was about
> feeding swine right: so I punched Garbage Disposal
>
> and the screen came blank—nothing! all those
> titles, row on row, of western goodies, mostly
>
> worse than junk, but not a word on Disposal: I
> should have looked, I suppose, under Waste Disposal
>
> but, who cares, I already got the point: I
> know garbage is being "disposed" of—but what
>
> I wanted I had gotten, a clear space and pure
> Freedom to dump whatever, and this means most
>
> of the catalog must go, so much that what is
> left will need no computer to be kept track of

This passage gives us Ammons's take on all those things that, in Thoreau's words, "the minister and the school committee and every one of you" have been at such pains to preserve. Like Thoreau, Ammons is also willing to dispose of "western goodies" in order to create "a clear space and pure freedom to dump whatever." If this sounds cynical or nihilistic, consider that the landfill is also the sort of "clear space" where wild things congregate, where terns flit about and enjoy the same "pure freedom to dump whatever," so that bird shit melds "enrichingly in with debris."[12]

Ammons shares Thoreau's skepticism about civility, but he is a lot more insouciant a skeptic than Thoreau ever managed to be. It helps, of course, not to be a Harvard-educated New Englander and a transcendentalist peculiarly exercised about matters of the spirit. It also helps to be a southerner of a certain background and generation, born and raised on a tobacco farm during the Great Depression, but footloose enough to have been a sonar operator in the South Pacific during World War II, a graduate student in California, a school teacher and principal on the Outer Banks, a businessman in New Jersey, and finally a professor of poetry at Cornell.

Ammons's checkered past is what enables him to say, with his trademark willingness to use whatever terms seem handiest and with a subversive twinkle, "we're trash, plenty wondrous." Thoreau might never have made a good picaro, whatever prodigies of pedestrianism he was capable of: he was too fastidious. Ammons is not the least bit fastidious. He understands that to be picaresque is not to flinch at trashiness, least of all our own, and he is more than willing to admit the scandalous proposition (scandalous, at least, from Thoreau's point of view) that "the intellect can be put by," not because it importunes the spirit too much, but just for the sake of pleasure:

one can turn to tongue, crotch, boob, navel,
armpit, rock, slit, roseate rearend and

consider the perfumeries of slick exchange,
heaving breath, slouchy mouth, the mixed

means by which we stay attentive and keep to
the round of our ongoing

Ammons's willingness to address "the perfumeries of slick exchange" and "the mixed means by which we stay attentive" should be regarded as exemplary by ecocritics. But they have followed Thoreau's example too closely and interpreted it too narrowly; as a result, ecocriticism has been overly concerned with forms of exchange and means of staying attentive that aren't slick or mixed, but chaste and purified. Ecocriticism has comported itself as if this were a world, as Ammons puts it, "with no bitter aftertaste or post coital triste."[13] Instead of being a lone voice crying in the wilderness, it, too, ought to "murmur *aptest eve*," and take up a position alongside the man on the dump.

If it did that, ecocriticism might become less and less anxious about linguistic forms of exchange and literary means of staying attentive. That those aren't everything they've been cracked up to be, that they are less important and more undefined than has been thought, is a point Ammons makes with wonderful vigor and, as always, disarming humor. After he describes his database search for information on garbage and the disappearance of all those "western goodies" from his computer screen (in the passage I quoted earlier), he broadens his point about the virtues of "clear space and pure freedom to dump whatever" by teasing out some of its implications for our self-representations and our representations of the world. Ammons writes:

har: words are a specialization on sound
making a kind of language: but there are many

not just languages but kinds of language: the
bluejay's extensive vocabulary signals states

of feeling or being—alarm, exasperation,
feeding, idleness—and the signal systems

lay out the states for the safety of sharing
by others, alerting to dangers, even sharing

food sources: whales' pod-songs keep intimate
transactions fluid[14]

Ammons readily admits that there is no common language. But he suggests that the commonality of language, of vocal and sonic means for "alerting to dangers" and keeping "intimate transactions fluid," means that "we are not alone in language," though "we may be alone in words." Even the whales "can turn to tongue, crotch, boob, navel" and "consider the perfumeries of slick exchange" on a scale befitting their immense being.

Of course, our aloneness in words sounds pathetic, and many ecocritics have seen it as the chief reason our own transactions, both with each other and with the world, aren't as fluid and as intimate as they might be, and have felt just a bit jealous of the whales as a result. But Ammons urges us to "for god's sake drop all this crap about words," so that we can return language in general and our own words in particular to something like their proper place in the pecking order of behaviors, human and animal. He writes:

our cousins the birds talk in the morning: I
can tell the weather by their voices before

I open my eyes: I know some of their "words"
because I know, share with them, their states

of being and feeling: my cousins the
robins tug worms up from the lawn and eat them

and that gives me a piece of conflictual reality
until I savor the hog in my bacon, admire the

thighbone in my chicken

The "conflictual reality" that Ammons is given a piece of in the song of the robins, in his bacon, and in the thighbone of his chicken isn't the sort of reality ecocritics have been imagining might be summoned up by the words that they admire. The reality that has excited ecocritics isn't of the sort one savors because it can be torn into with one's teeth or turned to the light in one's hand; it is of the sort one knows because it can be mirrored in one's mind—provided, of course, that one's thoughts and words are in order. The purported disparity between the reality one savors and the reality one knows has been perhaps the most important of my interests here. While writing *The Truth of Ecology*, I often remind myself of Ammons's observation that while "our language is something to write home about," it isn't the world: "grooming does for / baboons most of what words do for us."[15] I can't think of better words with which to end this book.