

Metaphors and Metaphysics in Ecology

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Abstract

The historical roots of contemporary ecology are grounded in metaphors that have at one time or another deemed nature a machine, an organism, a community, or a system. But descriptions such as these are not metaphors in the literary sense. They constitute cultural and scientific paradigms insofar as they stimulate and guide scientific practice. However, ecological metaphors do not refer to any metaphysical entity. They are at most useful fictions in terms of how they reflect the beliefs and values underlying a paradigm and do not exist independent of a theoretical framework. I trace the influence of these metaphors in the history of ecology from both the metaphysical and cultural points of view, and document a gradual transition from a belief in structural to conceptual natural order. This transition hinges on the realization that the metaphysical allegiances of ecological theories have been shaped by aesthetic considerations. By ridding ecology of its metaphysical pretensions, and recognizing that biotic communities or ecosystems are at most useful fictions, the task of the theoretical ecologist, then, is to craft useful and aesthetically compelling metaphors that accurately reflect the values held in contemporary culture.

The Concept of a Natural Order

Here I trace the conceptual history of ecology leading up to a paradigm shift from the balance-of-nature to the flux-of-nature. Then I provide an exposition of the cultural and scientific understandings of contemporary ecology—a science, I argue, that is driven more by aesthetic than metaphysical considerations.

Order is a value-laden concept. Whether it is social, political, psychological, even domestic, order is a value almost always preferable to disorder. Synonyms for disorder such as *disarray*, *disorganization*, *disintegration*, *instability*, *irregularity*, *chaos*, and *confusion* carry negative, often distasteful connotations. In the sciences this is especially true, where the rational order of data is not only valuable, but is a methodological necessity.

Arguably, one of the basic presuppositions necessary for the possibility of science is value-laden: the concept of a *natural* order. In *Science and the Modern World*, Alfred North Whitehead writes, “there can be no living science unless there is a widespread instinctive conviction in the existence of an *Order of Things*, and, in particular, of an *Order of Nature*” (1967, 5). By *Nature* (upper-case *N*), Whitehead here means the sum total of everything there is, something like *cosmos*, or “ordered whole.” Not incidentally, the term *cosmetic*, which we now associate with aesthetic adornment, derives from the same root word denoting order. Just as the belief in an order of *Nature* was necessary to make cosmology possible, the widespread belief that *nature* (lower-case *n*, i.e., terrestrial nature) has an intelligible order made natural sciences such as ecology possible.

Notice, however, that Whitehead only mentions a belief in *an* order of nature, not *the* order of nature. He does not mention that a belief in any specific kind of natural order is necessary for the possibility of science. This distinction is significant because for science to be possible, we must

only assume that there is *some* kind of natural order, though that order can later be described and understood in a plurality of ways. To do science, we must only assume *generally* that there is some kind of intelligible natural order.

But that order is not always easily understood. So to make it intelligible, some more particular, qualitative assumptions need to be made. Order in general is typically thought of as a *quality* that admits of differences in both kind and degree, and the same is true of natural order. The kind of natural order we assume will have implications in terms of just where that order exists. Two distinct kinds of natural order are *structural* and *conceptual*. If it is structural, it is objectively “real,” or “out there” in the natural world for us to discover. A belief in structural order is then a *metaphysical* belief—a belief that order exists *in* nature—independent of our concepts. On the other hand, if it is conceptual, natural order is subjective. Conceptual order is then contingent upon our concepts, which we project onto nature so it makes sense to us. A belief in conceptual natural order is a *cultural* belief—a belief that nature is as we describe it. It exists only as part of our conceptual apparatus, and is contingent upon historical, social, and cultural conditions.

There are also *degrees* of natural order ranging from simple to complex, from unified to diverse, from stable to chaotic. The degrees of natural order are related to kinds of natural order. For example, if we assume nature is simple, unified, and stable, it is more likely we will assume a natural order that is structural, since this degree of natural order is easier to discover in nature. We have no need to impose order *on* nature that seemingly already possesses it. On the other hand, if we assume that nature is complex, diverse, and unpredictable, the difficulty in making sense of it may require us to assume a natural order of a conceptual kind. In both cases, the practical necessity of making nature intelligible determines the kind and degree of natural order we assume when engaging in scientific practice. Thus, any particular qualitative assumptions about natural order

will be contingent upon our need to understand what nature is and how it works. To understand it, we had to assume there was natural order of some kind and in some degree.

One way to make nature more intelligible is to compare it to other, more familiar and comprehensible things. Since antiquity, we've drawn analogies to understand nature as if it were something else: as a divine plan, as a machine, as an organism, as a community, or as a system. Analogical thinking, or understanding one thing in terms of another, has a particular logic. If we think of nature as a machine, and we attribute the value of efficiency to machines, it follows that we attribute the value of efficiency to nature *as* a machine. The relevant attributes of the two analogues are then shared if the analogy is strong, and attributes are relative to, or a subset of, any given analogy.

Often there is a peculiar shift from analogy to metaphor, a transition from thinking of nature *as* a machine to thinking nature *is* a machine. The shift from "as" to "is" is subtle, but important. When thinking in terms of analogies, the comparisons we make are more explicitly hypothetical than with metaphors. While metaphors are notoriously vague, the power they have to communicate in a compelling fashion make them indispensable in the natural sciences—ecology in particular. Mostly metaphors for nature function as background assumptions, assumptions that are not made explicitly, yet continue to guide our perception of the natural world in novel ways. For example, when we hear "the natural world is a living organism," suddenly we view the natural world as either healthy or sick. If the natural world is a divine plan, we see design and perfection. If the natural world is a machine, we see efficiency and productivity.

We might think examples such as these only reveal the power of suggestion. But these metaphors have become deeply ingrained in our consciousness, so much so that we might now see

these expressions as indicative of a structural natural order. Oddly, the metaphorical concepts we employ to make nature intelligible become so entrenched that they somehow become metaphysical beliefs about a natural order independent of our concepts. Metaphors are not just literary devices or rhetorical flourishes, then, especially when they are employed in science. They reflect our culturally held values, beliefs, and attitudes regarding nature, the elements that comprise a worldview, or what Thomas Kuhn called a scientific *paradigm* (1962).

Thus there are two basic perspectives regarding natural order: metaphysical and cultural. The metaphysical perspective presumes there is an a-historical and necessary structural order in nature for us to discover and make intelligible. The cultural perspective presumes that making natural order intelligible requires metaphorical and historically contingent concepts. Whether these metaphorical concepts entail a belief in structural, metaphysical natural order is a question I will address later. But first, a brief foray into the history of ecology.

A Brief Conceptual History of Ecological Science

The historical roots of contemporary ecology are grounded in a succession of metaphors that have at one time or another deemed nature a divine order, an organism, a machine, a community, or a system. Here I trace the origins and influence of these metaphors from both the cultural and metaphysical perspectives, while showing how the two are related in ecological theory.

First, note the respective religious, biological, technological, and social origins of these metaphors. It's no accident that we've understood nature in terms of various conceptual frameworks tied to different historical and cultural eras. When theistic religious beliefs dominated our consciousness, we understood nature as designed by God. Animism, romanticism, and advancements in biology combined to form the organicist vantage point, from which we perceived

nature as a living being. With the advent of Newtonian physics and the industrial revolution came the mechanistic perspective, just as an emphasis on social and political cohesion brought on a communitarian explanatory framework. Now cybernetic systems structure the way we communicate, so we make nature intelligible by modeling it after the Internet. In each case, the dominant cultural paradigm offers a useful and unique way to model and understand the natural world via metaphorical concepts.

Each of these frameworks, however, is just another iteration of the most historically enduring metaphor for natural order—"the balance-of-nature." In "Changing Concepts of the Balance of Nature," Frank Egerton provides a thorough historical account for each of these iterations, which I won't repeat here (Egerton, 1973). Instead I look to a few seminal figures in ecology to provide some background leading up to the paradigm shift—a shift from the balance-of-nature to the "flux-of-nature."

The first iteration of the balance-of-nature metaphor that resembled a science of ecology (even before the term *ecology* was coined) was Carl Linnaeus' essay *Specimen Academicum de Oeconomia Naturae* (1751). Linnaeus' notion of the "economy of nature" implied that relationships between individual plants and animals functioned for the benefit of nature as an integrated whole.

To perpetuate the established course of nature in a continued series, the divine wisdom has thought fit, that all living creatures *should* constantly be employed in producing individuals, that all natural things *should* contribute and lend a helping hand towards preserving every species, and lastly that the death and destruction of one thing *should* always be subservient to the restitution of another (1759, 32 emphasis added).

Here we see the divine plan metaphor at work in a scientific text, and we can interpret this passage from both the metaphysical and cultural perspectives. First, note the normative language Linnaeus uses. From the metaphysical perspective, nature *should* follow the divine plan as designed. The balance-of-nature is structural: it is *in* nature, pre-established by God, as it ought to be. Yet from the cultural perspective, the normative prescriptions fall on us: we should conceive of natural order as the balance-of-nature—where individuals do their part for the good of the whole—if we are obedient members of a culture of believers. On this normative view, the two perspectives overlap. We should conceive of natural order—the economy of nature, or the balance-of-nature—as structural.

Just about any scientific theory in ecology following Linnaeus can be interpreted from either the metaphysical or cultural perspective. And each will have points where the perspectives overlap, because each theory postulates some characterization of natural order. Even the initial definition of ecology, from Ernst Haeckel who coined the term in 1866, isn't absent of any such postulates.

By ecology we mean the body of knowledge concerning the economy of nature—the investigation of the total relations of the animal both to its inorganic and its organic environment; including above all, its friendly and inimical relations with those animals and plants with which it comes directly and indirectly into contact—in a word, ecology is the study of all those complex interrelations referred to by Darwin as the conditions of the struggle for existence (translated and quoted by Allee et al., 1949, preface).

Must we presuppose the independent *existence* of an economy of nature to acquire this body of knowledge we call ecology? Or is only the *concept* of an economy of nature necessary to do ecology?

Consider another foundational text in ecology, Stephen Forbes's "The Lake as a Microcosm" (1887). Studying the lakes of Illinois, Forbes saw the parts-to-whole relationship "on so small a scale as to bring it easily within the mental grasp" (1887, 537). A lake, he says, "forms a little world within itself—a microcosm within which all the elemental forces are at work and the play of life goes on in full" (1887, 537). Because of the explicit analogy in the title of his essay, Forbes's version of the balance-of-nature epitomizes the appeal to analogical or metaphorical concepts in making nature intelligible.

Two ideas are thus seen to be sufficient to explain the order evolved from this seeming chaos; the first that of a general community of interests among all the classes of organic beings here assembled, and the second that of the beneficent power of natural selection which compels such adjustments of the rates of destruction and of multiplication of the various species as shall best promote this common interest (1887, 550).

In this heavily value-laden passage, we might again wonder whether this "community of interests" exists independently, or is merely a concept used to make sense of an otherwise chaotic mess.

American ecologist Frederick Clements (1916) developed a model of plant succession in which he argued that species succession is unidirectional and comes to a stable point of equilibrium known as the "climax community." All ecological roads, according to Clements, lead to the climax community, and any seemingly random disturbances to it are explained as temporary anomalies. Clements's later model of the climax community was holistic and organicist, where the

whole was more than the sum of its constituent parts, and the system emulated one large “superorganism” (1936). Thus Clements appealed to both the organism and community metaphors in his characterization of natural order, yet another iteration of the balance-of-nature.

Contrary to Clements’ holistic model, Henry Gleason (1926) argued that plant associations were in fact individualistic and accidental groupings, not organized parts honoring the single direction of a unified whole (1926). Gleason’s individualistic notion of plant succession carried with it the idea that biological organization is much looser and more subject to chance than previously thought.

It is small wonder that there is conflict in the definition and classification of plant communities. Surely our belief in the integrity of the association and the sanctity of the association-concept must be severely shaken. 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*? (Gleason 1926, 15-16).

As such, Gleason’s ecological theory is perhaps the least metaphysically charged: no entities other than individuals are postulated, and no metaphors are offered to make sense of natural order. This does not mean, however, that in Gleasonian ecology there is no natural order, or that no natural order is presupposed. Though no balance-of-nature characterization of natural order is given, natural order is a matter of chance, which is just as intelligible given a probabilistic conceptual framework. The Clements/Gleason disagreement between holism versus individualism set the foundation for much ecological thought that was to follow. Indeed, the new paradigm in ecology is the latest example of how this disagreement has historically played out (McIntosh 1985).

In partial reaction to Clements's climax community concept, Arthur Tansley (1935) coined the term (or postulated the entity) *ecosystem* to explain what he saw as dynamic change in natural environments. As in cybernetics, the structure and function of natural environments was systemic, and ecosystems achieved a state of what he called "dynamic equilibrium" (Tansley 1935, 300). The ecosystem concept accounted for dynamism in natural systems, albeit dynamism that maintained overall equilibrium. Thus in Tansley's ecosystem concept (or free-standing metaphysical entity), the balance-of-nature is still intact.

In "The Trophic-Dynamic Aspect of Ecology," Raymond Lindeman (1942) first theorized about systemic energy flow through ecological systems, focusing on *processes* rather than individuals. Eugene Odum (1953) further developed Lindeman's views by emphasizing the systemic nature of nature by modeling the patterns of energy flow through natural environments, complete with elaborate diagrams depicting circuitous inputs and outputs. Like Lindeman's emphasis on processes, Odum's contribution significantly expanded the focus of study in ecology beyond the species level, and advanced modeling techniques used in ecological research. Since ecological processes and energy flow patterns are not discrete entities, approaches such as Lindeman's and Odum's more easily fall under the category of cultural, rather than metaphysical characterizations of a balanced natural order. Even though they do not employ metaphorical concepts, these theories are dependent upon explanatory models, and models, like metaphors, cannot exist independent of a theory.

As each of these examples demonstrates, whether the postulation of metaphors and entities in ecology is meant to situate natural order in a cultural or metaphysical framework is difficult to determine. One interpretation is certain, however: each of the above examples was a characterization of the balance-of-nature. That was about to change.

The Flux of Nature Paradigm in Ecology

In *The Structure of Scientific Revolutions*, Kuhn describes how there are transitions from normal scientific practice, to the discovery of anomalous data, to theoretical crisis, to scientific revolution. He calls these transitions *paradigm shifts*, in which a fundamental altering of worldviews comes about via scientific practice. According to Kuhn, scientific practice does not stand in isolation from the social, historical, cultural, or psychological conditions surrounding it. Rather, the socio-historical context in which scientific practice is embedded articulates a paradigm. “No natural history can be interpreted in the absence of at least some implicit body of intertwined theoretical and methodological belief that permits selection, evaluation, and criticism” (Kuhn 1962, 16-17). Thus the foundation of scientific practice lies in a paradigm’s accepted research program that is largely determined by the underlying beliefs and values—the background assumptions held by members of a scientific community.

The call for replacing the old paradigm with the new is attributed to various co-authored essays by ecologist S. T. A. Pickett (Pickett and Ostfeld, 1995; Pickett, Parker, and Fielder, 1992; Pickett and White, 1985). To explicitly distinguish the new paradigm from the old, Pickett and Ostfeld (1995, 263-265) outline some of the basic assumptions of classical, balance-of-nature ecology, which are the following: (1) natural systems are closed, (2) natural systems are self-regulating, (3) equilibrium comes to a point, (4) succession is fixed, (5) disturbances to natural systems are exceptional, and (6) humans are excluded. The new paradigm in ecology challenges each of these assumptions, replacing the no longer plausible balance-of-nature conceptual framework with the more appropriate flux-of-nature metaphor (Pickett and Ostfeld 1995).

As we delve into the theoretical details of contemporary ecology, note how some of the terms it employs raise metaphysical questions of the sort we've been reviewing along the way. The new paradigm is a brand of *ecosystem* ecology where the landscape is described as a *shifting mosaic* (Pickett, et al., 1992). It postulates *patches*—spatiotemporal areas that are indefinitely bounded, and *disturbances*—fluctuations that indicate underlying natural *processes* governing ecosystem functions (Pickett and White 1985). Are ecosystems, patches, disturbances, and processes free standing metaphysical entities or culturally derived metaphors? Are they structural or conceptual characterizations of natural order?

Generally, the new paradigm may be best described as a “dynamic non-equilibrium” theory of ecosystem structure and function. Disturbances facilitate natural processes, transforming the landscape from one condition to another. More specifically, the new paradigm prioritizes the role of ecological processes over species interactions, mostly because species interactions are largely determined by natural disturbances. Pickett and V. Thomas Parker define disturbances as

biotic or abiotic interactions that influence dynamics. Any process may influence a number of ecosystem characteristics simultaneously. A clear example of this is the differential effect of a fire, killing some individuals or species while stimulating the germination of others. Fires also transform nutrient dynamics by mineralizing nutrients previously bound up in organic matter (2000, 17).

The ecological significance of fluctuations and disturbances runs counter to the balance-of-nature idea. Disturbances such as wildfires, fluctuations in climate, wind and soil erosion do not negatively disrupt the delicate equilibrium of nature, but characterize or punctuate its flux. “Such catastrophic events provide many people a rare opportunity to see *wilderness as a process* in parts

of the country where *wilderness as an entity* (e.g., a virgin forest) is never to be seen again” (Pickett et al. 1992, 81). That is, any ecological process that constitutes a disturbance, according to its scale and level of intensity—characterizes nature as in flux. According to Pickett and Ostfeld,

The term *flux* highlights variation, fluidity, and change in natural systems, rather than stasis, which is implied by the word *balance*. Although this metaphor does not deny the existence of stable points in nature, it focuses our attention on the fact that natural systems, which certainly do persist, do so as a result of a variety of fluxes (1995, 266-7).

Contemporary ecology thus acknowledges equilibrium, but only relative to a particular spatiotemporal *scale* (Callicott 2002a; 2002b). Since disturbances can occur on many levels and affect multiple ecosystem characteristics simultaneously and in very complex ways, scale is needed to measure the rate and extent of disturbances. Pickett and Ostfeld define *scale* as “the term used to describe the relationships between two measurements such as the extent over which a process occurs and the spatial extent of a system” (1995, 268). The apparent regularity or randomness, balance or imbalance, order or disorder, is relative to scale—the rate, intensity, and extent to which changes in natural systems occur. Ecosystems are neither perfectly integrated nor totally chaotic: natural order admits of degree.

In “The New Paradigm in Ecology,” the authors lament the fact that the general public is either unaware of or misunderstands contemporary ecology (Pickett et al., 1992). Unfortunately, the public’s understanding of ecology is still under the influence of the deeply ingrained notion of the balance-of-nature, as opposed to the now more appropriate “flux-of-nature” metaphor (Pickett et al. 1992, 66). Take, for example, the results of a questionnaire administered to undergraduate

ecology students. When asked: “what is meant by the balance of nature?” students responded that the balance-of-nature “is descriptive of real ecological systems, and continue to do so after instruction in ecological science” (Zimmerman and Cuddington, 2007). Such stubbornly held beliefs in the face of contradictory evidence reveal the depth of the cultural bias in favor of the balance-of-nature metaphor.

Both the balance-of-nature and flux-of-nature metaphors have ethical and aesthetic implications for our relationship to the natural world. I discuss the new paradigm’s implications for aesthetic appreciation of nature in chapter four. As for ethics, one reason for the cultural bias toward the balance-of-nature is that the bias is self-serving. If natural environments will resiliently return to delicate equilibrium, benign neglect is the best course of action—a comforting ethical prescription. But, on the other hand, under the flux-of-nature metaphor, we shouldn’t jump to the conclusion that anything we do amidst the flux is ethically permissible. There are limits to what fluctuating natural systems can tolerate, limits we should respect. Avoiding such misunderstandings requires an educational campaign that updates the public’s knowledge of ecology, and rectifies the incongruity between the public’s comforting yet false belief in the balance-of-nature and the scientific community’s rejection of that belief. Indeed, the belief in the balance-of-nature paradigm has resulted in a variety of poor policy decisions (Botkin, 1990).

From Structural to Conceptual Natural Order

If the ecological paradigm shift from balance to flux entailed a fundamental altering of our worldview regarding nature, one of the central elements of that shift was the abandonment of a metaphysical belief in structural natural order. Prompting that shift were observations of disorder in nature that didn’t fit with our metaphysical background assumptions. We could either drop our

metaphysical assumptions, or alter our conceptual framework to suit them. Either way, making that disorder intelligible required us to consider the idea that there is no way the natural world is independent of concepts. Perhaps it is only as we describe it. But this wasn't the first time this has happened. The transition from structural to conceptual natural order was underway long before the paradigm shift in ecology, and it has multiple iterations. Here I offer three brief examples to illustrate how this transition occurred previously: the positing of Newtonian physical laws, Darwinian contingency, and quantum indeterminacy. First a caveat: the three descriptions that follow are broad generalizations typical of the public's understanding (or misunderstanding) of their respective paradigms. The accuracy of the specific scientific details is not directly relevant to the questions I pose here.

By the nineteenth century the divine plan metaphor was no longer a plausible explanation of nature because it couldn't account for perceived imperfections in nature. The result was a transition beginning in the seventeenth century from a belief in structural to conceptual natural order that, according to Daniel Botkin, involved

The refutation of the idea that the world is composed of perfect structural symmetries—physical symmetries—for example, that the Earth is a perfect sphere, or that the planets move in orbits that are perfect circles....The belief in aesthetically pleasing and theologically satisfying physical symmetries was replaced by a belief in an aesthetically pleasing and theologically satisfying conceptual order. While the belief in gross physical attributes of symmetry, balance, and order was no longer tenable following the new observations of nature, Newton's laws created a conceptual order (1990, 108-9).

Rather than abandoning the aesthetic pleasure and theological satisfaction associated with a belief in a perfectly symmetrical structural natural order, Newton simply relocated that order in our conceptual framework (Newton, 1934). Thus imperfections and asymmetries in the divine plan were only perceived, and could be explained away by referring to perfect underlying physical laws. In making this move, however, Newton didn't abandon all metaphysical presuppositions. He only made them subservient to epistemic concerns. To discover the immutable laws of physics was to learn the language of God. In other words, perfect natural order was no longer *in* nature, but was codified in physical laws—a conceptually accessible divine plan that held nature's asymmetric ugliness at bay.

Similar to Newton's physics, Darwin's theory of evolution challenged our aesthetic sensibilities and metaphysical presuppositions in two ways: competition for resources and the process of random natural selection (Darwin, 1859). Competing for resources in the struggle to survive turned the landscape into a battlefield of selfish interests. While this culturally derived metaphor was for the most part consistent with the balance-of-nature, its connotations were socially unpalatable. In a state of denial, we assumed the natural world simply couldn't be that war-like in reality. This metaphor must only be a way of making it intelligible, an aesthetically offensive, yet useful fiction.

The process of random natural selection seemed to be more of an affront to our metaphysical than our cultural worldviews. The battlefield metaphor could be explained away as only a heuristic device. But the notion that species, including humans, evolved by accident was much more threatening. And random natural selection is radically contingent: it implies that there's nothing essential or necessary about the structure of the biotic world. It could have turned out differently, in countless possible ways. But this realization doesn't necessarily force us to do away with a

belief that there is a structural natural order. It may only challenge our assumption that we can comprehend and appreciate its complexity to a satisfying extent. More so than Newtonian physical laws, the complexity, randomness, and contingency involved in Darwinian evolution challenges our aesthetic, epistemic, and metaphysical presuppositions about natural order. Thus Darwin further advanced the shift from structural to conceptual natural order.

Quantum physics presents similar challenges. According to the so-called “Copenhagen interpretation,” the behavior of subatomic phenomena is observer-dependent and probabilistic, rather than observer-independent and deterministic, as in classical physics (Bohr, 1934; Heisenberg, 1958). Observer-dependence challenges our metaphysical assumptions simply because it implies that all natural order is imposed by observation. Thus there is no structural natural order to be discovered, we project a conceptual order onto what we observe. But quantum physics is equally problematic from the cultural perspective, since it doesn’t employ any metaphorical concepts that help make it intelligible. Moreover, the indeterminate, unpredictable behavior of quantum phenomena challenges some of our most deeply held epistemic convictions, the need for certainty in particular. Combine all of these difficulties and quantum theory becomes theologically, metaphysically, epistemically, and aesthetically distasteful. “God doesn’t play dice with the world,” Einstein famously said—a phrase that expresses real derision toward such a theologically discomforting worldview (1971). From a secular standpoint, the theological dissatisfaction Einstein felt is replaced by a *teleological* displeasure. Even without a belief in a designer, a random and unpredictable structural natural order appears to have no design or purpose—only a conceptual order could make sense of such chaos.

As these three examples show, certain knowledge of a structural natural order is too much to ask for. And an imperfect, asymmetrical, war-like, complex, accidental, unpredictable natural order

certainly isn't very attractive. Thus from Newton to Darwin to Bohr and Heisenberg, we see a gradual progression from a belief in structural to conceptual natural order. Slowly the metaphysical assumptions about nature became more and more difficult to maintain. But metaphysics wouldn't go quietly. The theological and teleological roots of our secular metaphysical beliefs were grounded in a practically important epistemic need to explain the natural world. Another expression of the will to believe in structural natural order is the view that scientific knowledge should correspond to reality. Of course, the plausibility of such a view is dependent upon there being "real" metaphysical entities that correspond to our scientific explanations. But we need not adopt metaphysical beliefs to satisfy our epistemic and scientific needs. We could satisfy those needs from the cultural perspective by employing metaphorical concepts—a strategy particularly well suited to contemporary ecology.

Ecology Without Metaphysics

In "A Succession of Paradigms in Ecology: Essentialism to Materialism and Probabilism," Daniel Simberloff suggests that "the chief reason for the persistence of the ecosystem paradigm is that it accords with Greek metaphysics" (1980, 29). He wrongly lumps all of Greek metaphysics into a single camp, and concludes (also incorrectly) that all of ecosystem ecology is under the spell of the balance-of-nature metaphor. And while the contemporary paradigm is decidedly contrary to the balance-of-nature idea, it is a brand of ecosystem ecology—albeit an ecological science in which ecosystems are "intangible," or are conceptual projections onto nature (Allen and Hoekstra 1992, 89). Simberloff's worry is that scientists and the lay public continue to adopt a metaphysical belief in structural natural order, that is, that the balance-of-nature exists. According to ecologist Charles Elton, this is simply a false belief. "The 'balance of nature' does not exist, and perhaps never has existed" (Elton 1930, 17). Whether or not the balance-of-nature exists metaphysically

speaking, Simberloff understands one reason why it persists as a concept: “[t]hat an idea so readily accepted by the lay public attracts professional adherents as well is not surprising, particularly when the idea has two-thousand-year-old roots” (1980, 30). Because of its long history, the balance-of-nature is a concept capable of seducing professionals in the field, even those who agree it doesn’t exist in nature.

Apart from the historical explanation, the balance-of-nature concept persists for another reason, and this reason is reflected in Simberloff’s language. Likening Clementsian, balance-of-nature ecology to Newtonian physics, he admits “[t]here is a tidiness, an ease of conceptualization, to well-defined ideals moving along perfect paths that is as appealing, both aesthetically and functionally, in ecology as it was in genetics and evolution” (Simberloff 1980, 16). As seen earlier, preserving the aesthetic appeal of a paradigm is as much a part of theorizing in ecology as it was in Newtonian physics. Darwinian evolution, quantum physics, and the shift from structural to conceptual natural order, makes that preservation not only possible, but necessary.

Certainly there is something profoundly disturbing about a nature in which random elements play a large role. Just as much of the opposition to Darwinian evolution powered by natural selection was engendered by the large role assigned to chance, so the idea of an unbalanced, stochastically driven natural community inspires distrust (Simberloff 1980, 30).

The flux-of-nature paradigm is as disturbing as the balance-of-nature paradigm is comforting. But the randomness and unpredictability involved in contemporary ecology not only inspires distrust, it inspires distaste. As Daniel Botkin puts it, “nature that is inherently risky may seem less beautiful than nature that is completely deterministic” (1990, 127). If we abandon the metaphysical

belief in a structural natural order (as we must according to the randomness and unpredictability associated with contemporary ecology), then we are left to decide which way of *conceiving* of natural order is more or less beautiful. Thus, contrary to Botkin's quote, nature isn't *inherently* risky or deterministic: we only conceive of natural order *as* unbalanced, or *as* risky. These metaphorical concepts are distasteful nevertheless. Why? What makes one conception of natural order better than another? Why is the balance-of-nature attractive and the flux-of-nature not?

In chapter three of *Beauty and Revolution in Science*, James McAllister discusses the relationship between scientific theories and what he calls their "metaphysical allegiances" (1996, 54-59).

Different theories exhibit, by virtue of their claims, allegiances to different metaphysical world views. A scientist who holds to a particular metaphysical world view may thus evaluate theories partly according to the metaphysical allegiances that they exhibit (McAllister 1996, 55).

My approach here has more to do with the public's understanding of ecological paradigms (including their respective metaphysical background assumptions or allegiances) than with how scientists evaluate theories, but I treat the relationship between theories and their allegiances in the same way as McAllister. As we have seen, the balance-of-nature is a deeply entrenched metaphysical worldview that has many instantiations in the history of ecological science; and each of those instances is exemplified by a metaphorical concept. Recall also that each metaphorical concept has its own associated aesthetic qualities that illustrate the balance-of-nature: machines are *efficient*, organisms are *healthy*, communities are *harmonious*, and systems are *integrated*. Integrity, of course, is the quality of ecosystems under threat in contemporary ecology. But

integrity (at least in the ecological sense) is a matter of degree. Under the flux-of-nature paradigm, the integrity of ecosystems isn't completely eliminated; ecosystems are only more or less integrated. In any case, the hierarchical relationship between a paradigm's metaphysical allegiances and its aesthetic qualities is the following. Ecological paradigms (e.g., the balance-of-nature) have metaphysical allegiances (e.g., structural natural order). Those allegiances are expressed in metaphors (e.g., ecosystem), and those metaphors have particular aesthetic qualities (e.g., integrity).

McAllister calls this the *customary* approach, in which a paradigm's aesthetic qualities are a subset of its metaphysical allegiances, "perhaps in the belief that scientists' aesthetic tastes are shaped by their metaphysical outlook" (1996, 55). He proposes an alternative, what I will call the *contemporary* approach, in which the relationship is inverted: metaphysical worldviews are shaped by aesthetic tastes (McAllister, 1996, 55). McAllister argues that metaphysical allegiances function as criteria for theory evaluation in the same way aesthetic criteria do—aesthetic criteria being prior to metaphysical criteria. I think the contemporary approach is correct, particularly when we consider the paradigm shift from the balance-of-nature to the flux-of-nature, because we have seen over the course of this transition multiple examples of preserving the aesthetic appeal of various theories. In this way the contemporary (as opposed to the customary) approach explains how a paradigm becomes increasingly entrenched. When scientists embrace a particular worldview, they tend to "seek further theories that show the same metaphysical allegiance," thus confirming the underlying aesthetic qualities that shape that worldview (McAllister 1996, 55-56). This is certainly the case with the balance-of-nature paradigm and its multiple iterations in ecology. Until the paradigm shift, each example we have seen of the balance-of-nature paradigm preserved the aesthetic qualities tied to their respective metaphors. Despite evidence to the contrary, nature was

an efficient machine, a healthy organism, a harmonious community, or an integrated system. When those qualities could no longer be attributed to nature in terms of a structural natural order, we preserved them as tasteful metaphorical concepts.

What makes the transition from the balance-of-nature to the flux-of-nature a Kuhnian paradigm shift is the change in aesthetic qualities that comprise the contemporary ecological worldview—a shift in the values, beliefs, and background assumptions held by members of the scientific and broader community. The problem is that the aesthetic qualities constitutive of the new paradigm are typically considered negative: imbalance, disorder, or disharmony. As a consequence, the new paradigm forces us to abandon our metaphysical pretensions (a belief in structural natural order) and adopt a more apt perspective—the conceptual, contemporary, cultural perspective. In other words, the structural, classical, metaphysical perspective can no longer be maintained in light of the randomness and indeterminacy associated with contemporary ecological science. Now the challenge is to replace the traditional, classical aesthetic qualities such as simplicity, symmetry, and balance with their contemporary ecological counterparts, and use those qualities to craft new, novel, and compelling metaphors that make nature more intelligible. The balance-of-nature and its kin are “dead” metaphors that now only express a blind faith in metaphysical abstractions.

If a paradigm’s metaphysical allegiances are shaped by our tastes, then the paradigm shift from balance to flux is an aesthetically driven paradigm shift. Thus the call for a new “ecological metaphysic” (Ulanowicz, 1999) is nothing more than a call for new ecological aesthetics—a call for “live,” more useful, more novel and compelling metaphors. But again, we should resist the temptation to think of these metaphors as referring to entities with metaphysical status (Keller and Golley 2000, 24-27). From the conceptual perspective, they are at most useful fictions that help us

interpret the scientific facts. As *useful* fictions, they provide the interpretive framework necessary to make sense of the data and therefore must accurately reflect the beliefs and values held in contemporary culture. As *fictions*, they must be good fictions—they must guide research and further our understanding of the natural world in compelling, novel ways. In this sense, metaphors and their associated aesthetic qualities are *constitutive* of ecological theories and paradigms insofar as they usefully and compellingly make nature intelligible (Boyd 1993, 519).

Conclusion

Here I have traced the concept of a natural order and its many iterations through the history of ecology leading up to the paradigm shift from the balance-of-nature to the flux-of-nature. Along the way we saw a gradual transition from a belief in structural to conceptual natural order that reached its apex in contemporary ecological theory, resulting in a replacement of the metaphysical perspective with a cultural perspective. The reason for this transition hinges on the realization that the metaphysical allegiances of ecological theories have been shaped by aesthetic considerations. By ridding ecology of its metaphysical pretensions, and recognizing that biotic communities or ecosystems are at most useful fictions, we should understand that the task of the theoretical ecologist is to craft useful and aesthetically compelling metaphors that accurately reflect the values held in contemporary culture. Gaining that understanding of how ecology works only further dispels the myth of a value-free science.

References

- Allee, W. C., Alfred E. Emerson, Orlando Park, Thomas Park, and Karl P. Schmidt.
1949. *Principles of Animal Ecology*. Philadelphia: W. B. Saunders.
- Allen, T.F.H. and W. Hoekstra. 1992. *Toward a Unified Ecology*. New York: Columbia University Press.
- Bohr, Niels. 1934. *The Philosophical Writings of Niels Bohr, vol. I*. Woodbridge: Ox Box Press.
- Botkin, Daniel. 1990. *Discordant Harmonies: A New Ecology for the Twenty-first Century*. New York: Oxford University Press.
- Boyd, Richard. 1993. Metaphor and Theory-change: What is “Metaphor” a Metaphor for? In *Metaphor and Thought*, ed. Andrew Ortony, 481-532. Cambridge: Cambridge University Press.
- Callicott, J. Baird. 2002a. Choosing Appropriate Temporal and Spatial Scales for Ecological Restoration. *Journal of Bioscience* 27: 409-420.
- _____. 2002b. From the Balance of Nature to the Flux of Nature: The Land Ethic in a Time of Change. In *Aldo Leopold and the Ecological Conscience*, ed. Richard L. Knight and Suzanne Riedel, 91-105. Oxford: Oxford University Press.
- Clements, Frederick. 1916. *Plant Succession: An Analysis of the Development of Vegetation*. Washington, D. C.: Carnegie Institution of Washington.
- _____. 1936. The Nature and Structure of the Climax. *The Journal of Ecology* 24: 252-284.
- Darwin, Charles. 1859. *On the Origin of Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life*. London: John Murray.
- Elton, Charles. 1930. *Animal Ecology and Evolution*. New York: Oxford University Press.
- Egerton, F. N. 1973. Changing Concepts in the Balance of Nature. *The Quarterly Review of Biology* 48: 322-350.
- Einstein, Albert. [1971]. Letter to Max Born, December 4, 1926. *The Einstein-Born Letters*, trans. Irene Born. New York: Walker and Company.
- Forbes, S. A. 1887. The Lake as Microcosm. *Bulletin of the Illinois State Natural History Survey* 15: 537-550.
- Gleason, Henry. 1926. The Individualistic Concept of the Plant Association. *The Bulletin of the Torrey Botanical Club* 53: 7-26.

Haeckel, Ernst. 1866. *Generelle Morphologie der Organismen: Allgemeine Grundzüge der organischen Formen-Wissenschaft, mechanisch begründet durch die von Charles Darwin reformierte Descendenz-Theorie*.

Heisenberg, W. 1958. *Physics and Philosophy: The Revolution in Modern Science*. London: George Allen and Unwin.

Keller, David D. and Frank B. Golley. 2000. Introduction: Ecology as a Science of Synthesis. In *The Philosophy of Ecology: From Science to Synthesis*. Athens: University of Georgia Press.

Kuhn, Thomas. 1962. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press.

Linnaeus, Carl. 1751. Specimen Academicum de Oeconomia Naturae. *Amoenitates Academicae* II: 1-58.

_____. 1759. *Micellaneous Tracts Relating to Natural History, Husbandry, and Physick*, trans. B. Stillingfleet. London: R. and J. Dodsley.

McAllister, James. 1996. *Beauty and Revolution in Science*. Ithaca: Cornell University Press.

McIntosh, Robert. 1985. *The Background of Ecology: Concept and Theory*. Cambridge: Cambridge University Press.

Newton, I. 1934. *Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His System of the World*, trans. A. Motte. Berkeley: University of California Press.

Odum, Eugene. 1953. *Fundamentals of Ecology*. Philadelphia: Saunders.

Parker, V. Thomas and S. T. A. Pickett. 2000. Restoration as an Ecosystem Process: Implications of the Modern Ecological Paradigm. In *Restoration and Sustainable Development*, ed. K. M. Urbanska, N. R. Webb, and P. J. Edwards, 17-32. Cambridge: Cambridge University Press.

Pickett, S. T. A. and Richard Ostfeld. 1995. The Shifting Paradigm in Ecology. In *A New Century for Natural Resources Management*, ed. Richard L. Knight and Sarah F. Bates, 261-278. Washington, D.C.: Island Press.

Pickett, S. T. A., V. T. Parker, and P. L. Fielder. 1992. The New Paradigm in Ecology: Implications for Conservation Above the Species Level. In *Conservation Biology: The Theory and Practice of Nature Conservation, Preservation, and Management*, ed. P. L. Fielder and S. K. Jai, 65-88. New York: Chapman and Hall.

- Pickett, S. T. A. and P. S. White. 1985. *The Ecology of Natural Disturbance and Patch Dynamics*. Orlando: Academic Press.
- Simberloff, Daniel. 1980. A Succession of Paradigms in Ecology: Essentialism to Materialism and Probabilism. *Synthese* 43: 3-39.
- Tansley, Arthur. 1935. The Use and Abuse of Vegetational Concepts and Terms. *Ecology* 16: 284-307.
- Ulanowicz, Robert E. 1999. Life After Newton: An Ecological Metaphysic. *Biosystems* 50: 127-42.
- Whitehead, Alfred North. 1967. *Science and the Modern World*. New York: The Free Press.
- White, P. S. and S. T. A. Pickett. 1985. Natural Disturbance and Patch Dynamics: An Introduction. In *The Ecology of Natural Disturbance and patch Dynamics*, ed. S. T. A. Pickett and P. S. White, 3-13. San Diego: Academic Press.
- Zimmerman, Corinne and Kim Cuddington. 2007. Ambiguous, Circular, and Polysemous: Students' Definitions of the "Balance of Nature Metaphor. *Public Understanding of Science* 16: 393-406.