DO LANDSCAPES LEARN?

Ecology's "New Paradigm" and Design in Landscape Architecture

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For the past two decades, the academic field of ecology has been undergoing a quiet shift in the concepts and philosophy which shapes ordinary theoretical and field investigations. These changes in the underlying assumptions that support ecological research have been called ‘the new paradigm,” in contrast to the prevailing perspective that influenced our understanding of the natural world for the previous century.[1]

One may ask, what implications does this “new paradigm” have for disciplines with ecological applications such as conservation, ecological restoration, and landscape architecture?[2,3] The value of this new perspective may depend upon how ecological knowledge is used in practice. On the face of it, there are two obvious ways in which an understanding of ecology can assist landscape architects in their work. A design project usually involves a serious intervention and rearrangement of the land, and a biological understanding of the consequences may help the architect predict and control the outcome of the intervention. Second, the narrative of ecology, and the feelings an ecological perspective may provoke, can serve as inspiration for the aesthetic challenge facing the designer.

However, I think there may be a third value in understanding the work of ecologists and the implications of a shift in perspective. Briefly, the designer may begin to see the conduct of ecological studies as an engagement with the land and its inhabitants, analogous to but philosophically distinct from landscape architecture. This third value may then serve to initiate a deeper dialogue between the ecologist and the designer.

If this is to occur successfully, at least partly as a result of this essay, I should probably reveal something of my own background in ecological research that has led me to the views expressed here. For years I studied populations of wild violets growing in the woodlands of New England. The question behind my research was simple: if you are female, why bother with sex when asexual reproduction is perfectly adequate? Female plants frequently reproduce without sex[4], leading to a clone of identical individuals. I wanted to understand why, in an evolutionary sense, sex ever evolved.

The chosen species of particular interest to me was a white-flowering, short-stemmed violet called Viola blanda. It forms a rosette of leaves in the leaf litter of the forest floor in early May of each year, and it is a denizen familiar to anyone who frequents the wetter parts of our New England woodlands. Out of the axil of its leaves, where the leaf stem or petiole meets the main stem, emerges a new shoot. It grows somewhat like a branch except that it remains horizontal just below the surface of the soil. This runner or stolon is leafless and grows through the summer to distances of twenty or more inches from the mother plant.

As the days of autumn grow shorter, extension growth ceases and the tip of the shoot turns up to barely emerge from the soil. It overwinters in this form, and the warming of the soil in April stimulates the emergence of leaves and the initiation of roots that will give this daughter plant independence from its mother. Throughout the following season, the daughter now repeats the cycle, forming one or more stolons that in turn create granddaughters and great-granddaughters, all at different locations across the forest floor.

I studied the formation of these clones by marking seedlings and censusing each one repeatedly through the season and over a number of years. When the growth of any new stolons stopped each fall, I would mark the new locations of the potential daughter plants. If they survived winter and emerged the following spring, I would add them to my census population. In this way I could track the formation of clones and know the underground connections among the plants in my population.

As you might imagine, such a demographic approach to watching violets grow involved many, many hours spent on my knees tracking individual plants. Over the eight years of my research I befriended about eight thousand violets. I discovered that any one individual lives a relatively short life, perhaps four or five years. However, this plant is replaced by her genetically identical daughters and granddaughters, although in different locations. In this sense the clone or genetic individual was capable of surviving indefinitely through the asexual production of new generations.

There was, however, an entirely different interpretation one can place on this pattern of life and death (Fig. 1). Because daughters and granddaughters are genetically identical to the mother plant, they are the same individual from an evolutionary point of view. In essence, the mother plant doesn't die; she survives in time in a form we call daughters and granddaughters through growth in space. The "adaptation" of the clone in the forest understory is its "movement" across the forest floor.

The key to understanding this spatial pattern lay in my willingness to track the temporal pattern of change over multiple years. The clone is growing horizontally, rather than vertically, through the production of physically distinct plants that are genetically identical. And it is this dynamic movement of the clone in space that prompts a set of new questions about clonal behavior. Is this movement random, or could it be directed, perhaps to locations of higher resources such as sunlight or mineral nutrients? Are clones foraging for "food" over the forest floor?

After 1983, my career turned away from the investigations that could answer such questions, but the perspective toward the natural world that they reflect -- a dynamic, constantly changing nature -- is consistent with the influence of the “new paradigm” that was overtaking academic ecology during the years of my violet studies. To understand the significance of this influence, it will be instructive to describe how the “old paradigm” became established.

Ecology as a science really began as plant ecology before the turn of the century. Botanists were developing taxonomic schemes to describe and classify the diversity of plant communities found growing on the land. This included both different looking communities with different plant species growing in different regions of the world and different assemblages of plants growing at different times in the same location. By the end of the 19th century, botanists understood that, for any one location, there was a recognizable sequence of plants that invaded a site following a severe disturbance, such as fire or land clearing for agriculture. The sequence of species that came and went in stages usually ended with a community composition similar to that found before the disturbance. This process was called succession.

The intellectual father of ecology was Frederick E. Clements, a botanist who grew up in the grasslands and prairie regions of this country. His fifty year career of prolific writings left an enduring imprint on the science of ecology. He created the old paradigm. Trained in floristic taxonomy characteristic of 19th century botany, Clements believed that one could understand the proper classification of plant communities if one could understand how they came to occupy land rendered bare by disturbance. Clements brought a holistic perspective to his beliefs about vegetation consistent with much intellectual thought at the time. He argued that the plant community, the whole assemblage of species found growing together on a site, was actually a single living organism. As such, it displayed characteristics of development, integration, and homeostasis similar to an individual plant or animal. In 1905 he published his first ecological book called "Research Methods in Ecology," with this description of the plant community, then called a formation: "Vegetation an Organism[sic] -- The plant formation is an organic unit. It exhibits activities or changes which result in development, structure, and reproduction...According to this point of view, the formation is a complex organism, which possesses functions and structure, and passes through a cycle of development similar to that of the plant...As an organism, the formation is undergoing constant change.[5]

Clements concept of vegetation as a kind of super-organism, propounded in numerous books and papers in the first half of this century, had an enormous appeal for many individuals entering the discipline of ecology as a subfield of botanical study. It became an alternative to the strongly reductionist tendencies seen in physiology and genetics, and its spiritual qualities reinforced the emotional feelings experienced by individuals who spent thousands of hours in the field investigating the natural world. This was also a time when the metaphor of the organism influenced the intellectual development of disciplines well outside ecology.[6]

I do not want to recite the long history of this old paradigm's hold over the field of ecology, but I will note one important transformation that developed in the decade before the Second World War. The concept of the plant community was expanded to include all the animal inhabitants, and it was redescribed in terms of two fundamental processes that give life to the “superorganism”: the flow of energy through the community and the cycling of non-organic elements such as hydrogen, oxygen, nitrogen, and carbon. The “superorganism” was transformed into the “system” and the whole acquired the name, “ecosystem.” Following the War, the science of ecosystem studies began to grow rapidly; and a new language describing the dynamics of energy and nutrients came to dominate the discipline of ecology in this country.

Although description of a natural system in energetic terms would seem to be reductionist in nature, ecosystem ecology retained a strongly holistic interpretation: the healthy ecosystem is an integrated, efficiently functioning entity that can be defined, described, and measured quantitatively. Reference to the “superorganism” disappeared from the words of ecologists, but descriptions of the functional properties drew on a language heavily characterized by organismic attributes. Ecosystems display homeostasis and self-regulation. When disturbed by outside forces, they exhibit a process of regeneration that is described as a predictable series of developmental stages that continues until a mature and healthy equilibrium is reached.

The leading textbook of the time, “Fundamentals of Ecology” by Eugene Odum (first edition, 1954; last edition, 1971), contains a summary chapter, “The Strategy of Ecosystem Development” that states: “Ecosystem development, or what is more often known as ecological succession...is an orderly process of community development [that] is reasonably directional and, therefore, predictable...succession is community-controlled...It culminates in a stabilized ecosystem in which maximum biomass and symbiotic function between organisms are maintained per unit of available energy flow...The development of ecosystems has many parallels in the developmental biology of organisms, and also in the development of human society.[7]

The influence of this older, holistic paradigm, also called the "equilibrium paradigm", went well beyond academic ecology, especially with the rise of environmentalism in the 1960s. "Design with Nature" by Ian McHarg, now considered a classic fusion of ecology and landscape planning, is suffuse with a spiritual and holistic interpretation of the natural world. He writes: "Ecologists describe the thin film of life covering the earth as the biosphere, the sum of all organisms and communities, acting as a single superorganism."[8]

Four major elements characterize this equilibrium paradigm. First, ecological systems in their natural state are closed, self-regulating systems. Energy efficiently sustains the maximum state of biomass, and nutrients cycle within the system without significant loss. Second, the system in its most mature state is in a condition of balance or equilibrium. The forces of nature causing change (i.e. disturbance) are external to the system. Third, when the system is disturbed by outside forces and degraded to an earlier developmental, less efficient state, an ecological process known as succession changes the system through a sequence of predictable stages to restore the original conditions and return the system to an equilibrium condition. Finally, the activities of humans are not part of the natural world and are often in conflict with its operation. The influence of human culture is largely negative, acting as an agent of disturbance that undermines the balanced, stable equilibrium of the mature and healthy system.

The transition from one paradigm to another was brought about in the 1980s by several factors.[9] The first was the influence of evolutionary theory on ecology through its causal explanations, especially the mechanism of natural selection. New ecology textbooks began to appear in the 1970s that fully incorporated population genetics and population biology into ecological theory and practice. From this perspective, a community or ecosystem is a collection of populations, and the whole is not greater than the sum of the parts.

Along with a population approach to ecology came a statistical and probabilistic perspective for understanding complex natural phenomena. There was growing recognition that chance played an increasingly large role in the way the natural world worked. Finally, the accumulation of evidence from long-term, historically-oriented studies of natural systems overwhelmingly indicated that nature was very unruly and seldom behaved in a way consistent with the ideal models and predictions of the old paradigm. Despite a tenacious, century-old hold over the minds of ecologists, and despite the popularization of a holistic ecology for political and religious ends, the metaphor of the organism has been gradually replaced by the "new paradigm."

If the older paradigm can be characterized by its equilibrium, balance-of-nature, perspective, the "new paradigm" emphasizes the dynamic and changing nature of communities and ecosystems.[10] First, they are no longer seen as closed, self-regulating entities; boundaries are much more complex and difficult to define than this would imply. Changes in the composition of a community can be greatly influenced by factors outside the system, thus expanding the scope and complexity of the ecological knowledge required to understand its local dynamics.

Secondly, disturbance is a frequent, intrinsic characteristic of ecosystems. They are constantly subject to varying degrees of physical disruption from natural forces, and species exhibit a wide range of adaptations to disturbance. Fire, windstorm, landslide, flooding, and the mortality of plants and animals that result, are all intrinsic elements of every natural setting, leaving most communities resembling a patchwork mosaic of species usually representing very different stages of succession.

Succession itself is now viewed as a highly probabilistic process that can be greatly influenced by local conditions and the particular order of events that occurs. In other words, what was considered a highly predictable, universal process is actually highly contingent on history and context. Successions may display multiple pathways and multiple end states, if an end state is ever reached.

Finally, in the “new paradigm”, humans can be and usually must be considered part of the system. This is a recognition of the overwhelming influence of human culture on all natural systems, and the world-wide impact of certain cultural practices such as the burning of fossil fuel, the release of ozone-destroying chlorofluorocarbons, and the introduction of alien species. It challenges any clean distinction between culture and nature, and reaffirms the necessary inclusion of human factors and their effects in any study of a “natural” system.

The use of the word “paradigm”, whether old or new, implies a certain language used within a discipline, almost independent of the underlying concepts and assumptions. It will be instructive to look with some detail at two case studies from the practice of ecology to see the play between evidence, concepts, and language.

The first case is the classic example of succession that has been cited in many textbooks since it was first described in 1923.[11] At Glacier Bay, Alaska, the resident glacier has been melting and retreating north at a rate of about half a kilometer a year since 1750 (Fig. 2). The valley left in its wake has been filled with seawater to form Glacier Bay, and all along the shore the glacier has deposited till consisting of a variety of silty and sandy sediments containing pebbles, stones, and large rocks in a homogeneous outwash with no nutrient content.

Succession begins when these sites are invaded by plants. An initial community of mosses and herbaceous species is followed by low growing willows, cottonwoods, and alders. The alders soon spread into thickets which are in turn invaded by sitka spruce. After a century, the spruce forest completely shades out the lower growing alders and is itself infiltrated by mountain and western hemlock. This mixed spruce-hemlock forest is considered to be the final or climax stage of the succession reached after a period of 200 years.

Studies conducted after World War II[12] revealed a parallel pattern of soil development. Nitrogen-fixing herbaceous species and alders increased the nitrogen content of the soil, and the decomposition of acidic alder leaves lowered the initially high, alkaline condition of the glacial till. These changing conditions permitted the seedlings of spruce and hemlock to successfully colonize, and the increasing level of nitrogen accelerated tree growth and the accumulation of organic carbon in the soil.

This tidy narrative -- a predictable sequence of plant species parallel with, and presumably caused by, a predictable sequence of soil development -- was a classic case of primary succession in leading textbooks up until the present decade. However, the description of this succession is not based on observations of a single site over a 200 year period; no ecologist is that dedicated or long-lived. Instead study plots were established at different distances south along the shoreline of Glacier Bay. Sites nearest the edge of the glacier were the youngest and sites one hundred kilometers away at the mouth of the Bay were the oldest. This methodology assumes that the sequence of plant communities seen in space accurately describes the sequence of plant communities that will occur at one site over a two hundred year period; that is, spacial variation is presumed to mirror temporal variation.

Beginning in 1987, Christopher Fastie, a graduate student at the University of Alaska, decided to see if a historical reconstruction of single sites over time actually matches the description of the successional sequence as seen in the spatial comparison of multiple sites.[13] To do this he took core samples out of the trunk of each tree and reconstructed the history of its growth by measuring each annual growth ring under a microscope. The history of the site could then be reconstructed from a knowledge of the growth of its individual trees.

To give you a feel for the scale of the work involved, let me describe Fastie's sampling plan. He identified 10 study areas in the sequence from north to south (Fig 2) and set up ten 10x15 meter study plots at each site. He supplemented this with 35 additional plots as needed. Within each of these 135 plots, he counted and measured all seedlings and saplings by species, and he cored every tree. He even cored any dead trees in the plots to determine the time of germination and the time of death. Each tree was cored six times and each core was sanded smooth and its growth rings measured to within 0.01 millimeter accuracy. I estimate that Fastie carefully looked at and measured 10,000 to 12,000 tree cores. In addition, he did an analysis of soil at all 10 study areas. Using meticulous statistical methods, he recreated the forest history at each site based on the direct evidence displayed by the wood of each tree.

Fastie found that the actual history sometimes differed considerably from the classic successional narrative. The three oldest sites closest to the sea displayed an invasion of spruce and hemlock much earlier than expected, and there was little evidence that alder thickets were ever a dominant part of the early forest history of these sites. The middle-aged sites were covered with alder thickets and their presence seems to greatly delay the invasion of spruce and hemlock. At the very youngest sites located over 60 kilometers from the sea and much closer to the glacier, cottonwood rather than alder was coming to dominate the earlier phases of vegetational change.

Thus Fastie identified three distinct pathways of succession at Glacier Bay, all within a comparatively short distance of each other. In addition, he noted that the oldest sites are currently under attack from the spruce bark beetle which is killing all canopy spruce in some stands. This new disturbance may have been facilitated by declining tree vigor due to low nitrogen availability in the soil. Fastie speculates that spruce trees colonizing younger sites, where nitrogen-fixing alder thickets have previously been dominant, may have greater resistance to such insect outbreaks, and may therefore experience a very different history as much as a century later. He concludes: "The existence of qualitatively distinct pathways at similar sites at Glacier Bay demonstrates that no single sequence of species replacements and no single mechanistic model of plant community change is mandatory...Multiple pathways of compositional change at Glacier Bay appear to be a function of landscape context, which, in conjunction with... dispersal capabilities and generation time, affects seed rain to newly deglaciated surfaces and thereby alters the arrival sequence of species...The single species differences early in succession at otherwise similar sites at Glacier Bay therefore could have substantial consequences for successional pathway and ecosystem function for many centuries."[14]

My second case is drawn from much closer to home. For more than 80 years, the Harvard Forest in Petersham, Massachusetts has had an interest in catastrophic natural disturbance. Established as the site of a traditional school of forestry practice after the turn of the century, large tracts of white pine and hemlock growing on its lands were severely damaged by the 1938 hurricane that destroyed forests throughout central New England. After the Second World War, research directions at Harvard shifted from questions of applied biology such as forest production to more basic issues involving the structure and functioning of natural ecosystems. Today the Harvard Forest is a leading center for the study of the effects of disturbance on forested landscapes.

Dr. David Foster, director of the Forest, and his colleagues have conducted a series of studies that have revealed the role of natural disturbance in the temperate forests of the northeastern United States.[15] In southwestern New Hampshire, for instance, there is a small parcel of forested land called the Pisgah Tract that was never cut for timber. This virgin or primeval forest today looks like many of the second-growth woodlands found throughout New England growing on abandoned farmland, except that on the forest floor, surrounded by sixty year old birch, maple and oak trees, lie the fallen, decaying trunks of huge, one-hundred foot white pine and hemlock trees that were once part of the old-growth forest. They were all blown down in four hours on September 21, 1938, and a new forest has grown up around them.

Through methods of historical reconstruction similar to those described in my Glacier Bay example, Foster has meticulously revealed the history of this site back to

1635 when a powerful hurricane destroyed the forest and was followed, thirty years later, by widespread fire. Over the subsequent 300 years, the site was subjected to seven damaging windstorms or hurricanes, six widespread fires, and three broadscale attacks by pathogens. This pattern of regular disturbance shaped the composition of the forest through the death of large trees and the recruitment of new seedlings. It was this patchwork plant community, dominated by large hemlocks and white pines, that was destroyed in 1938 and followed by recruitment of a forest of very different composition.

Foster's interest in the functioning of the temperate forest ecosystem goes beyond an understanding of the past.[16] At present the human species is engaged in a very large scale experiment. Through our cultural activities over the past century, we have increased the concentration of carbon dioxide in the atmosphere by 30%, with every indication that this and future increases will lead to a world-wide rise in the average temperature of the earth's surface. In addition, cultural activities have more than doubled the amount of nitrogen being introduced into natural systems world-wide and this promises to continue increasing, creating a very large fertilization experiment with unknown consequences. While we ordinarily think of human disturbance to nature in terms of forest clearing and agricultural production, a much more global and chronic source of disturbance will involve fundamental changes to biogeochemical cycles. How, Foster asks, do the responses of forests to these chronic disturbances compare to similar responses to catastrophic disturbance?

To find out, Foster set up a series of experimental plots in 1990. In one, he used a power-driven winch to pull over all the trees in one direction, thereby simulating the effects of a hurricane. In a second, he placed heating coils below the soil surface and raised the average temperature by five degrees centigrade. Finally, he fertilized a third plot with nitrogen monthly between May and October. He subsequently measured the responses of plants to these three experimental manipulations. He has also tracked changes in key nutrient processes in the water and soil of the forest following each treatment.

While the experiment has only been running for six years, some preliminary conclusions are quite interesting. As one might expect, pulling over 250 mature trees in the middle of a forest caused immense structural damage, with an additional 400 trees more or less affected. In addition, the uplifted root systems created a series of huge holes in the forest floor and the erosion of the soil clinging to roots formed mounds of soil beside these pits. The forest floor was covered with broken debris and litter.

Regeneration of the forest began immediately. Snapped and fallen trees sprouted new shoots from branches and roots. Forty percent of the trees pulled over managed to survive and recover. New seedlings and saplings soon appeared and grew quickly in the open sunlight. Within four years a new canopy of young trees and survivors had formed.

Foster anticipated that such chaotic disruption of the forest and soil structure would have a great impact on the water and nutrient processes that are critical to ecosystem functioning. However, he found no evidence of any change. The movement of carbon and nitrogen was very similar in the hurricane simulation plots and the controls that experienced no disturbance.

Such was not the case in the fertilizer and soil warming experiments. These plots showed no changes in the structure and composition of the forest, at least not yet. There was some increase in leaf litter production in the fertilizer experiment, but the forests looked very similar in appearance to the controls. Despite this, measures of carbon and nitrogen cycling indicated major changes. Heating the soil greatly increased the release of carbon dioxide from the soil into the atmosphere and more than doubled the rate of nitrogen mineralization, a measure of nitrogen release in the soil. This implied a profoundly altered soil environment. Similarly, in the fertilizer experiment, the rate of nitrogen immobilization in the soil increased nearly 100% over the six years of the experiment without any effect on the rate of carbon dioxide release. It is not known where this nitrogen is being stored.

Although he intends to continue monitoring these experiments for many years to come, Foster concludes: "Whereas the blowdown site appears severely disturbed, internal processes have not been altered significantly, and the stand is on a path to recovery of structure and function in keeping with the cyclic pattern of disturbance and development of this forest type. By contrast, the chronic nitrogen and soil warming plots are visually intact and apparently healthy, yet the subtler measures of ecosystem function suggest serious imbalances, with possible future implications for community structure, internal ecosystem processes, and exchanges with the global environment."[17]

From these two ecological examples, we have a picture of the natural world as one of continual change: the flux of nature rather than the balance of nature. The pattern of this change is highly local and contingent on a particular sequence of historical events, and this can create a very heterogeneous spatial pattern on the land. The causes of the visible changes may be quite invisible and the outcome of particular causes may be highly probabilistic; chance can have a strong influence on change. The pattern of change at one site may be complexly related to causes at a great distance or to large-scale processes with small, cumulative effects. Humans have long been a part of the natural world, but have come to dominate it in the past century.

So how, we may now ask, can this picture of a contingent, fluctuating and dynamic nature be of any use to the practice of landscape architecture. Let us return to my framework possibilities noted earlier: ecology as knowledge; ecology as inspiration; and ecology as a basis for a conceptual dialogue.

I will make the assumption that landscape architects, if given the choice, would prefer to design landscape interventions that maintain or improve the ecological “health” of the land. Isn’t this what “sustainable design” means? To this end, a deeper understanding of the workings of the natural world would seem to be helpful. The problem, of course, is knowing how any particular intervention affects the “health” of the land.

Landscape architects seem to be at great odds over the role of ecology vs. aesthetics in their work.[18] And the concern seems to be, almost to the point of dogma, that anything really creative or fun must be “unhealthy” and certainly sinful. But do we know this to be true, at least true the way scientists understand truth? Is there a literature of statistical studies that measure and document the impact of ordinary landscape interventions on the degree of “health” exhibited by the land, in a way analogous to clinical trials that measure pharmaceutical effectiveness and side effects?

I suspect there is not, leaving the matter prey to ideology and politics. We ecologists are at least partly to blame. Who wants to spend several years monitoring the biomass production, nitrogen dynamics, and water budget of the Dumbarton Oaks gardens when you could be freezing your toes taking tree cores at Glacier Bay?

But the problem is more difficult than this when it comes to measuring ecosystem "health". Ecologists are pretty good at declaring the patient near death or dead, and the measurements to back up this judgment are pretty easy to acquire and understand. But detecting a slight temperature rise or a arthritic limp is not nearly as simple. Natural systems are naturally resilient, and hide their illnesses until they are really ill. And ecologists have not developed methodologies to measure the more suble effects of cultural manipulations of the land.

With the ascendancy of the "new paradigm," this may change. Humans are now part of the natural world; and the ecological study of human interventions, even at the scale of landscape architecture, has become okay for sympathetic ecologists. Within the past year, a multi-million dollar grant was awarded by the National Science Foundation to a study entitled: "Human Settlements as Ecosystems: Metropolitan Baltimore, Maryland, from 1797 to 2100."[19] Can clinical trials for ecological impact of the perennial border or the linden allee be far behind?

Given the difficulties in defining "health" and the lack of empirical evidence that ordinary landscape design interventions are "unhealthy" or ecologically irresponsible, perhaps a neutral stance in the war between aesthetics and ecology is called for. My own bias inclines toward the position recently articulated by Louise Mozingo[20] who sees no necessary zero-sum game between ecologically sensitive design and the aesthetic expression of the designer. She calls for the infusion of a new aesthetic into traditional ecological design which, she argues, often leads to boring, unexciting landscapes invisible to ordinary people. She writes: "The lack of aesthetic value of most ecological design lends it a ploddingness that is neither appealing to us as designers, nor as humans.

It creates a kind of landscape hairshirt that may make some feel holy but sends too many of us running to the nearest Italian garden."[21]

Mozingo's new ecological aesthetic would be built on five qualities that traditionally contribute to the creation of iconic designs of notable aesthetic value: visibility, temporality, reiterated forms, humanistic expression, and metaphor. In each of these domains, Mozingo finds the rhetoric of ecological design in conflict with any aesthetic language. But it is not at all clear that the preservation of critical ecological processes negates the actual use of such a language in constructed landscape projects. She challenges ecological designers to reassess their morally superior, functionalist perspective: "While ecological design is clearly an ethic, it is not, at present, fully conceived as an aesthetic...Successfully promulgating ecological design requires the recognition and application of culturally based aesthetics."[22]

The value of such a new ecological aesthetic, successfully integrated into the practice of landscape design, would seem to rest on a deep and subtle understanding of the natural world by the designer. How else will he or she know that a particular aesthetic expression is likely to be "healthy?" I think this calls for a rigorous scientific understanding that distinguishes fundamental ecological processes from the visual and superficial ecology of natural history. Armed with such an understanding when approaching a particular site, the designer is much freer to identify a set of aesthetic possibilities that preserve or have minimal impact upon the critical ecological functions of the land. Are landscape architects prepared to acquire, either as practitioners or students, the necessary level of scientific literacy that this implies?

There may be growing opportunities for defining a scientifically-grounded aesthetic in the expanding field of ecological restoration.[23] The science of such highly disturbed sites may be more readily accessible, and the recovery process is often more forgiving of experimentation. The aesthetic challenges are usually obvious. Yet I do not sense that landscape architects have been leaders in the intellectual development of this field. The theory of ecological restoration seems to have be largely the province of engineers, ecologists, and new-age philosophers.[24]

An deeper scientific understanding of the natural world can also provide a second kind of value to landscape architects as a source of inspiration, both as motivation and as artistic idea. I don't have very much to say here, except to plea for clarity. To a scientist there is a clear distinction between a decision based on a disciplined and critical understanding of a phenomenon, grounded in community consensus, and a decision based on a more personal, hypothetical perception of that phenomenon. Both are equally valid, but they are different. Too often in writings about design in landscape architecture, the former is brought forth as authority and disguise for the latter, and the hybrid becomes more of a politically correct imperative rather than a personal expression of feelings. Several years ago Ann Spirn captured this point perfectly: "Ecology as a science (a way of describing the world), ecology as a cause (a mandate for moral action), and ecology as an aesthetic (a norm for beauty) are often confused and conflated...It is important to distinguish the insights ecology yields as a description of the world, on the one hand, from how these insights have served as a source of prescriptive principles or aesthetic values, on the other."[25] Clarity about the nature and sources of inspiration would seem to be most easily achieved when it is based on a solid understanding of science and its limits as authority for aesthetic and moral decisions.

There is a third way that the scientific nature of ecology can inform landscape architecture. It is here that the "new paradigm," by its contrast with the old, may be most helpful. To make my point, I want to consciously caricature the way ecologists and designers think about their work. Beth Meyer recently published a long essay called "The Expanded Field of Landscape Architecture."[26] Meyer has a pretty explicit agenda in this paper which does not concern me here. Instead I would like to look at the conceptual language she chooses to serve her theoretical frame. After setting aside the inherited binary distinctions that divide much discussion of landscape architecture, Meyer calls on three "new figures" to characterize her argument: "The figured ground is that undulating body between the figural object and neutral field, between mass and void. It finds structure in the ground, its topographic and geological structure. The articulated space is the space between figural space framed by buildings and open space, homogeneous and undefined. This is the realm of the spatiality of plants, hedges, hedgerows, allees, bosques, orchards, and forests; it is a space of layering, ambiguity and change. The minimal garden, also called the garden without walls, relies on patterning the ground plane to create a visible landscape. The surface -- what is usually undefined -- is transformed into a horizontal object that defines an implied space above it -- like a Persian rug on the floor."[27]

What strikes me about the language chosen here is how spatial it is. At the risk of overstating my point, landscape architects think spatially and practice their discipline spatially. The very roots of the compound word, land and scape, derive from spatial references: "As far back as we can trace the word, land meant a defined space, one with boundaries...scape...once meant a composition of similar objects...landscape is...a synthetic space, a man-made system of spaces superimposed on the face of the land."[28]

A design is a spatial object, usually represented in the two dimensional plan and the three dimensional model. Designers give form to their inspirations through manipulation of objects on the surface of the land and the creation of unique spaces. How different this way of thinking is from that of the ecologist.

Take the "new paradigm" compared with the old. The "superorganism" as a metaphor for the climax, steady-state plant community or ecosystem is an idealized concept of a relatively static, unchanging natural world. The "new paradigm" replaces this fixed, balance-of-nature model with one that is dynamic, contingent, full of change and uncertainty. For an ecologist, what is interesting about nature is what happened yesterday and how it informs us about what will happen tomorrow. The temporality of nature <u>is</u> nature, and insights based on spatial perceptions alone are highly suspect without an understanding of the underlying dynamic processes that created the spatial configuration. This is why an individual will carefully measure the annual growth rings of ten thousand tree cores, or spend six years on his knees watching violets grow.

If the language of landscape architecture is essentially a spatial language, what is the analogous language for ecologists? I think it is mathematics. Scientists use mathematics to describe the dynamic flux of nature, whether it is the probability of events (statistics) or the description of rates of change (calculus). For the designer, spatial langauge seems closely linked with the eye and the translation of its perceptions into new spatial configurations. The ecologist distrusts the eye and brings great effort and discipline to the process of acquiring data that unmask the guises of the eye. No wonder "ecological design" is sometimes treated as an oxymoron.

Laurie Olin, discussing his own collaborative work with ecologists practicing wetland restoration, is clear on this difference: "Of great interest to me was their disinterest in what their work looked like...in their early work, they tried to make their new and restored habitats look like those they had studied...They had discovered, however, that many things died, some grew by leaps and bounds...and other things just turned up. They found themselves engaged in a sort of wilderness gardening for a few years until the systems and various populations took hold...As a result, they said now they do not bother trying to make a site look "pretty"...What nature looks like, or is supposed to look like, appears to be our problem, a cultural matter; it has little to do with ecology."[29]

Of course, landscape architects may not need to worry about time. Clients care a lot about how things look, especially while they are paying the fee. The client will have to deal with time later, long after the designer has cashed the check.

Perhaps this is too cynical, however. Just for fun, we can think about how the "new paradigm" in ecology might suggest a renewed acknowledgment of temporality in landscape design. Such a temporality is one critical element of Mozingo's call for a new aesthetic: "Landscape aesthetics prizes a static vision imposed upon the land...Conventional design sees landscape change not as a vital, imaginative force but as a frightening or disappointing one...The acceptance of change, of moving beyond the fixed vision of the landscape, is ecologically necessary."[30]

There is a loose analogy here with architecture, and I'd like to conclude by turning to one recent, very funny critique of that profession. Stuart Brand has written a book entitled "How Buildings Learn" with the subtitle "What Happens After They're Built". Throughout my reading of this book, I found myself creating a parallel volume by substituting the words landscape architect for architect and landscape for building. What might this second book look like?

Brand argues that architects do not care about buildings once they are built: "I recall asking one architect what he learned from his earlier buildings. 'Oh, you never go back!' he exclaimed. 'It's too discouraging'...Facilities managers have universally acid views about architects. One said, 'They design it and move on to the next one. They're paid their fee and don't want to know.[31] My approach is to examine buildings as a whole -- not just whole in space but whole in time...In the absence of theory or standard practice in the matter, we can begin by investigating: what happens anyway in buildings over time?...Time is the essence of the real design problem.[32] If you think about what a building actually does as it is used through time -- how it matures, how it takes the knocks, how it develops, and you realize that beauty resides in that process -- then you have a different kind of architecture. What would an aesthetic based on the inevitability of transience actually look like?"[33]

Brand goes on to frame the issues through the lens of traditional high-style architecture compared with vernacular approaches, and he argues that the real life of buildings begins with occupancy: "A building "learns" only through people learning...Loved buildings are the ones that work well, that suit the people in them, and that show their age and history...What makes a building learn is its physical connection to the people within.[34]

Brand sees the need for a new body of research, the study of buildings in time: "There is a shocking lack of data about how buildings actually behave. We simply don't have the numbers. To get beyond the anecdotal level...will take serious statistical analysis over a significant depth of time and an adventurous range of building types...What might be learned from highly detailed longitudinal studies of buildings in use? What changes from hour to hour, day to day, week to week, month to month, year to year, and over decades? This kind of study is the norm in ecology and some of the social sciences; there's no lack of lore about how to do it.[35]

So, returning to the landscape, our "new paradigm" ecologist might rightly ask: How do designed landscapes behave after they are built? Do we have any longitudinal studies that document their interactions with their inhabitants, how they "learn" and adapt, and are adapted to, and come to be loved? Do landscape architects want to go back and find out what happened? How would one study the evolution of some famous landscapes after they were built? Would such a temporal aesthetic, informed by the real life of landscapes, give new meaning to "ecological design?"

My intent in conducting this exercise in Brandian quotation is not to criticize the work of designers, but to suggest that it may not be complete, especially as it is described in the literature of landscape architecture. Perhaps the "new paradigm" in ecology may stimulate a different dialogue between ecologists and designers around a renewed acknowledgement of temporality in landscape architecture. In one sense, all landscapes are vernacular landscapes, in that they are designed to work and to be worked by people.

Working landscapes (landscapes that work) are dynamic in ways that hopefully express the intent of the designer, not as a spatial object but as a successfully designed system of processes. Perhaps the language and literature of landscape architecture could begin to acknowledge that the learning of landscapes is as important as their creation. “A building is not something you finish,” notes Brand, “A building is something you start.”[36]

FOOTNOTES

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FIGURES

Figure 1. This schematic sketch of the life cycle of a Viola blanda plant shows the way in which the distribution of growth shifts to younger generations as the clone moves

slowly across the forest floor, continually acquiring new locations. A single plant lives only five or so years; by the fourth year, the vigor of the original seedling plant is greatly reduced, while clonal daughters and granddaughters are thriving.

Figure 2. Location of 10 study sites at Glacier Bay. Positions of glacier termini from historical maps and photographs (1794 and 1879-1994) or from the measurement of tree cores (1750, 1825, 1840) are indicated. Location of Glacier Bay National Park and Preserve in southeastern Alaska is indicated (arrow).

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