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TO LIFE!

ECO ART IN PURSUIT OF A SUSTAINABLE PLANET

Linda Weintraub

Introduction

Eco Art Is / Eco Art Is Not

THE URGE TO GIVE VISUAL FORM to personal sentiments, communal purport, economic conditions, spiritual beliefs, aesthetic values, and institutionalized agendas originated approximately forty thousand years ago. Humans have been creating art ever since, inventing countless devices to manifest their cultures' identity. These impulses are being expressed with a mixture of exuberance and vengeance by today's eco artists. The following chapters chart an advancing course of art today, identifying the contributions of new recruits eager for environmental reform. They also provide examples of the progenitors of today's eco art movement. This exploration begins with the 1960s because those were watershed years when the elements that distinguish eco art in the twenty-first century become palpable. In the 1960s, European and American cultures split into two contrasting camps: "counterculture" and "culture."

"Counterculture" was unified by its opposition to the stultifying conformity and spiritual vacuity of mainstream culture. Otherwise it was a mélange of specialized oppositions to diverse concentrations of authority. White society was attacked by the civil rights movement, commercialism by a new spirituality, universities by student protestors, rationality by psychedelic drugs, patriarchal power by the women's movement, and sexual restraint by the availability of birth control pills.

"Culture" was represented by escalation of the industrial sector, resulting in the rapid expansion of affluence. The word *revolution*, which is often affixed to these changes, was primarily engendered by technology, investment, and engineering. The term is misleading because it conjures images of abrupt and violent overthrows of a system that quickly crumbles, being replaced by an alternative that is so unprecedented it shatters expectations and demands radical adjustments. Twentieth-century technological "revolutions" altered the gadgets, making them bigger, faster, lighter, tougher, and more powerful, but the game remained the same. None challenged the assumption that it was good to amass power over the environment and exercise it to expand the population, longevity, and ease of humans.

The Green Revolution that emerged in this era and that is currently emerging in human societies across the globe may actually warrant the term *revolution* because it reverses this relentless drive. Zero population growth, voluntary simplicity, back-to-the-land movements, organic farming, vegans, birders, solar energy users, recyclers, alternative architectural practices, sustainable land development, community-supported agriculture are all indicators of a wholly new paradigm. These trends acknowledge ecological laws as the basic operants of the planet. They are instigating a profound shift in consciousness that really does seem revolutionary because they reverse the age-old course of human chauvinism. It is replaced with recognition that humans are merely a type of mammal sharing space on the planet with all other species.

Once the meaning of *human* shifts in this manner, all human interactions become eligible for redesign. This entails the observations and data and methods of the ecologist. But it relies equally upon the inventive creativity of the artist. Eco artists are attuned to lead the revolution toward a sustainable future. This book is a rallying cry to readers to join their crusade.

Eco Art Is

"ECO ART IS . . ." IS AN INCOMPLETE SENTENCE that all the pages in this book attempt to resolve. While new concepts are introduced by each chapter, eco art's extraordinary diversity coexists with a thread of commonality. These works share such descriptive nouns as *experiment, exploration,* and *inquiry,* suggesting that eco artists may be testing the limits of art's tolerance for change. Thus, examining eco art raises such quandaries as these:

Is innovation an essential aspect of a masterwork of art?

Is an understanding of past art a prerequisite for appreciating vanguard art?

These pesky and persistent questions have been swarming around Western art since the collapse of the guilds in Europe after the Middle Ages. That is when cultural attention shifted from the otherworldly domain of infinity and eternity to this-worldly interest in materiality and progress. The transformation established the dynamic course of civilization that has been accelerating and intensifying to this day. Along that course, the pathways of work, family, recreation, governance, and spirituality have resembled lanes, byways, arterials, detours, and occasion dead ends. Comparable routes chart the dynamic course of art.

IS INNOVATION AN ESSENTIAL ASPECT OF A MASTERWORK OF ART?

Most of the artists who have earned enduring esteem have dislodged existing standards of art. Nonetheless, innovation does not ensure renown. History demonstrates that two additional criteria are essential to earning masterwork status—the characteristics of artistic innovation must correlate with the nature of changes occurring in society at that time, and the degree of novelty must be synchronized with the extent and intensity of these changes.

How is this accomplished? Expanding art's mediums is one way artists throughout the ages have fulfilled these criteria; for example, clay and bronze factored into past avant-gardes because they were once novelties. Employing newly invented technologies is another means to introduce meaningful change in art; tube paint, welding guns, and lasers mark a succession of technological adoptions by avant-garde artists. Acknowledging a changed locus of influence is another strategy; for example, art made for domestic interiors instead of cathedrals and castles was innovative in the seventeenth century. Eco art perpetuates this pedigree because the scales, mediums, processes, and themes it is introducing are correlated with compounding environmental woes and humanity's determined efforts to rectify them. Its innovations address the uncertain fate of life currently existing on planet Earth.

Although some eco artworks promote sensory and emotive engagements, the overt functionality of much eco art introduces a particularly disputed form of innovation. Because it frequently seems indistinguishable from engineering, gardening, farming, researching, educating, and so forth, eco art can tamper with the popular assumption that art engages the human spirit. Two responses defend including pragmatic practices within the realm of "art."

First, art that focuses on the practical requirements of survival already appears on the historic trajectory of art innovations. Consider, for example, the many cultures where art functions as offerings to gods who reciprocate the favor by producing rain, multiplying flocks, healing the sick, curdling milk, and raising the sun. Second, artists typically serve the needs of their contemporaries. In the past, art has awakened devotion in times of spiritual unrest and it has aroused protest in times of suppression. Now art innovation is including utilitarian strategies regarding pollution, resource depletion, climate change, escalating populations, and so on, because the strategies that sustain us are threatened.

IS AN UNDERSTANDING OF PAST ART A PREREQUISITE FOR APPRECIATING VANGUARD ART?

Every art interaction is individualized. It is a product of a person's knowledge, intuition, interest, and mood. Familiarity with past art offers one of many ports of entry. Since the far-reaching innovations that eco artists are initiating comprise the content of this book, it is simply a fact that some people will relate this work to poets William Blake and William Wordsworth, or environmentalists Aldo Leopold and John Muir, or painters John Constable and Claude Monet, or philosophers Aristotle and Murray Bookchin. However, readers with none of these reference points need not despair. It also suffices if their context consists of a landscape painted with skill, observed sensitively, and rendered faithfully, or trips to Disney World and the Magic Kingdom, or Discovery Channel specials. All these possibilities provide portals for assessing eco art's explorations with temperature, moisture, sunlight, wind, water, topography, compaction, chemical change, plants, animals, microbes, and human cultural patterns.

In addition to defending its status as art, eco art must also justify its adoption of the prefix *eco-*. On one level, this is satisfied by noting the shared goal between ecologists and artists participating in today's environmental movement—they all actively strive to ensure the vitality of Earth's ecosystems. Four attributes refine the identification of eco art with ecology: topics, interconnection, dynamism, and ecocentrism. These attributes serve as routes for navigating the inspiring profusion of eco artworks. New discoveries are continually being made at their intersections, feeding the ever-evolving expanse of eco art.

Topics that apply to eco art comprise a vast spreadsheet of opportunities that are derived from the rigorous methods of ecologists and the subjective considerations of environmentalists. On the one hand, artists influenced by ecologists glean topics of consideration from three sources: nonhuman organisms, the nonliving environment, and human actions. Every temporal, spatial, behavioral, physical, and chemical possibility on Earth is accounted for within these three categories. On the other hand, artists who behave like environmentalists enrich this topical abundance by adding intuition, opinion, and interpretation. Their shared environmental agenda, however, rarely produces consensus regarding causes of observed phenomena or strategies to protect or rectify them. As a result, eco art encounters are replete with surprises. Some artists, for example, place faith in nature's own healing powers, while others trust human ingenuity. Some focus on local remedies while others adopt global perspectives.

Interconnection is the inescapable law of links and relationships that govern all materials, all processes, and all events on Earth. Eco art that manifests this principle accepts the influences of fluctuating humidity, temperature, sunlight, fungus, bacteria, mice, and humans. Glossaries of ecological terms affirm the centrality of interconnections to this discipline. They reference, for example, *system, network, synergy, coevolution, community, commensalism, mutualism, symbiosis, competition, mimicry, feedback,* and *succession.* The ecological axiom that no object is separate and no force is isolated has engendered a host of new disciplines that replace their former separatist identities. They are known as behavioral ecology, urban ecology, social ecology, acoustic ecology, political ecology, industrial ecology, Christian ecology, and media ecology, to name a few. Oddly, the term used to refer to art that embraces the abiding truth of connectivity is *eco art,* not *art ecology.*

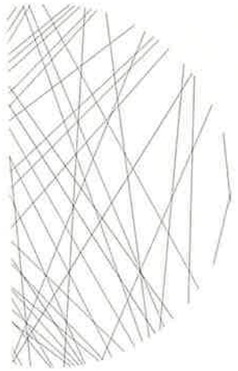
Dynamism acknowledges that anything occupying space also transforms through time. Eco works of art that incorporate this attribute submit to the perpetual permutations that account for life on Earth by melting, evaporating, growing, mutating, dying, and so forth. While flux is inevitable, its tempo is variable, determined by the inherent responsiveness of a medium and the intensity of surrounding influences. Some artists choreograph this dynamic duet so that it proceeds according to plan. Others allow their works to yield to conditions they do not predict or wish to control.

Ecocentrism refers to the principle that humans are not more important than other entities on Earth. It is the opposite of anthropocentrism, which interprets reality in terms of human values and experiences. Societies founded on anthropocentrism cultivate "the humanities" and focus on human constructs, not natural systems. Furthermore, they honor "humanitarian" efforts to privilege the welfare of humans, not other living entities. The ecocentric alternative urges humans into alignment with broader environmental directives. It interprets reality as Gaia, the Earth goddess of the ancient Greeks. In 1979 James Lovelock, the renowned independent scientist and author, evoked the Gaia hypothesis that focuses on interdependence and mutuality, as applicable to humans as any other form of life. Ecocentric artists may choose to manifest this theory by inviting living entities and inert forces to create the physical, structural, and functional attributes of their works of art.

In sum, eco art's defining features can be constructed out of these four attributes:

- Topic identifies the dominant idea and determines the work's material and expressive components.
- Interconnections apply to the relationships between the physical constructs of a work of art and between the work of art and the context in which it exists.
- Dynamism emphasizes actions over objects, and changes over ingredients.
- Ecocentrism guides thematic interpretations as well as decisions regarding the resources consumed and the wastes generated at each juncture of the art process.

Since no single work epitomizes all four attributes, and no attribute alone conveys the range of eco art's thematic and material components, this book presents a panorama of examples. The burgeoning arena of contemporary eco art is disclosed, therefore, from two vantage points. Individual works of art delineate the components of this cultural landscape. The overview becomes visible only at their intersections, through relationships, and in combination.



Eco Art Is Not

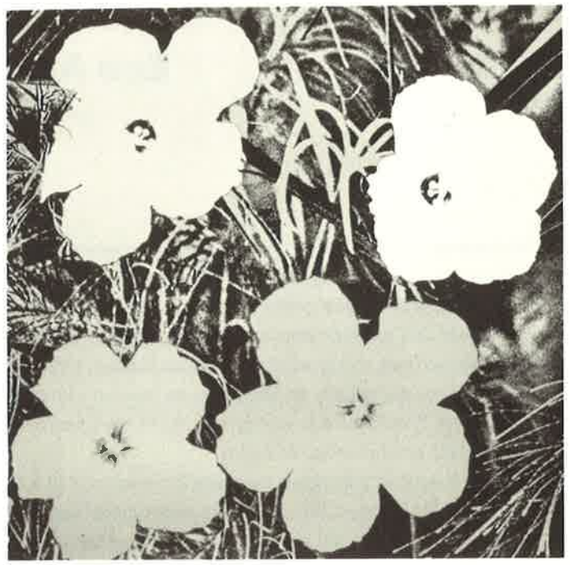
WHEN "TO LIFE!" RESOUNDS at gatherings of well-wishers and grievers, it is reserved for one particular species—humans. Its exclusivity characterizes anthropocentrism, the perception and interpretation of earthly phenomena in terms of human experience and values.

If, however, ecologists and environmentalists were to exclaim "To life!," the object of their toast would include microbes, plants, animals, and their habitats. Individuals who share ecology's commitment to the perpetually shifting, infinitely layered montage of living entities manifest ecocentrism. The ecocentric worldview honors life's sanctity, augments its diversity, protests its neglect, and optimizes its vitality.

The word *ecocentrism* entered the English language in the 1970s after a zealous minority arose to proclaim that rights belong to all species, not just humans. Ecocentrism envisions humans as components of interconnected systems. These systems are more essential to the planet than any of the individuals or objects found here.

The Twentieth-Century artists who joined this cause established the strategic and perceptual underpinnings of current eco art. These eco art pioneers challenged the assumptions that nonhuman forms of life are important only to the extent that they are useful to humans. The imprint of this anthropocentric supposition defined the cultural norm. It was evident in the era's prevailing notions of utility, beauty, ethics, recreation, spirituality, politics, and so forth. This essay provides a sampling of such anthropocentric notions by exploring three of its manifestations: productivity, longevity, and perspective. Each is revealed through a Twentieth-Century vanguard art movement: pop art, land art, and conceptual art. The individual examples of each were created by artists renowned for being among the originators of these movements: Andy Warhol, Walter De Maria, and On Kawara.

All three vanguard movements revolutionized fine art protocols. Ironically, they accomplished this transformation by affirming the cultural values that mainstream culture absorbed throughout this turbulent era. It is remarkable, therefore, that none of these examples of pop, land, or conceptual art was fueled by cultural dissent. It was left to eco artists to dispute the ethics and prudence of these transformations and implement reforms. Citing these movements, therefore, provides a means to convey the renegade character of eco art. Besides establishing its oppositional stance, such antithesis clarifies the principles that propel eco artists' bold explorations. Thus, the question, What is eco art? is answered in this essay by explaining what eco art is *not*. The text prepares readers to acknowledge eco art's contribution to art of the 1960s and 1970s as a deviation from a cultural norm that, remarkably, included vanguard art. This deviation exists even when Warhol depicts flowers, De Maria engages weather, and Kawara interprets landscape. While these subjects appear related to the considerations that fuel eco art, none of these artists addresses these issues from the vantage of a sustainable planet. Instead, they remain loyal to anthropocentric perspectives.



Andy Warhol | Flowers | 1964 Offset lithograph on paper | 23" × 23"

PRODUCTIVITY: POP ART (ANDY WARHOL)

Andy Warhol demonstrates that paintings of flowers in full bloom in a field don't necessarily evoke the beauty of nature or the concerns of environmentalists. His pop art paintings have more in common with General Electric, Ford, General Motors, Chrysler, IBM, Bell Telephone, US Steel, Pepsi-Cola, DuPont, RCA, and Westinghouse. The unprecedented productive capacity of these industrial giants was being celebrated by lavish displays at the 1964 World's Fair in New York City, the same year Warhol initiated his *Flower* series.

Although Warhol also showcased the abundance that infused American society in the mid-twentieth century, he did not depict a shoppers' paradise. Instead, his attention went behind the scenes to the processes responsible for both the production of cheap goods and the generation of popular imagery. He then reconfigured the production of his art to match the machine's takeover of culture and landscape, replacing the sensibilities, aesthetics, and skills associated with fine art with the mechanized production, assembly-line routines, and commercial strategies of non-art material production. These art practices occurred in a studio he renamed the Factory to indicate his radical artistic goal—to minimize inputs and maximize output. Warhol summed up his artistic intentions when he declared, "The reason I'm painting this way is that I want to be a machine, and I feel that whatever I do and do machine-like is what I want to do."[1]

Between June and July of 1964, Warhol created seven large paintings showing four Mandrinette flowers at peak bloom. The image of this prized hibiscus was mass-produced by a legion of Factory assistants who completed as many as eighty small *Flower* paintings per day. Warhol exclaims, "Friends come over to the Factory and do the work with me. Sometimes there'll be as many as fifteen people in the afternoon, filling in the colors and stretching the canvases."[2] Printmaking, even more than painting, enabled Warhol to exploit factory production strategies. By adopting a simple reproductive technique known as silk screen, the factory accelerated and increased its output of images. Perhaps the most radical confirmation of the industrial ethic was the strategy he devised to demonstrate that in an age of mass production, the multiple takes the place of the original. Warhol signed all the works that emerged from the Factory whether or not he was personally involved in their production.

Warhol's adoption of the cultural norm is apparent in the contemporary context in which he acquired the flowers he painted. Instead of growing in a field or garden, these flowers appeared in the June 1964 issue of *Popular Photography* magazine. The flowers had little connection with living botanicals. Instead, they were captured mechanically with a camera and processed industrially when they were developed and printed.[3] Warhol's process is a tribute to the machine and its takeover of natural occurrences. His style of representation further accentuated these cultural insignia. The images were altered by subtracting the flowers' textures and shading, pressing their spatial complexity into a flat decorative pattern, and then adding the hypersaturated hues common on '60s miniskirts, go-go boots, and psychedelic record album covers. Through these devices Warhol reformulated flowers into the glaringly artificial depictions of nature on tissue boxes and gift wrapping, earning them esteem as emblems of contemporary reliance on industrial manufacture.

Anthropocentric Productivity

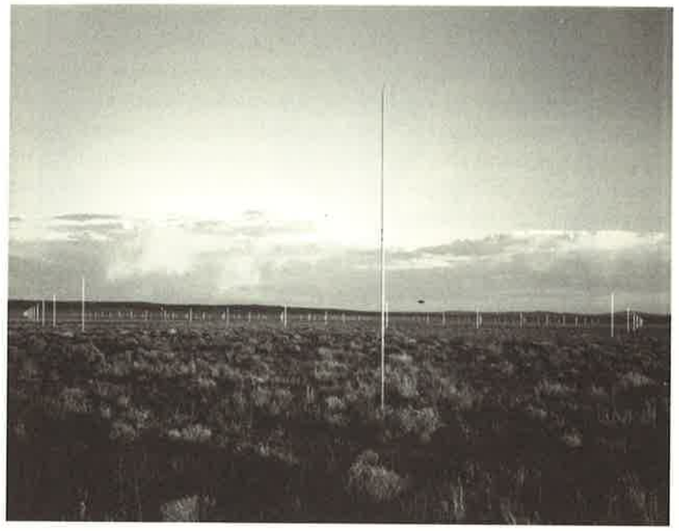
The flowers Warhol represented were neither grown like botanicals nor created like art. They were assembled like cars. Their production encapsulates the anthropocentric reliance upon commerce and industry. Warhol's Mandrinette blossoms are as laborsaving as TV dinners, as synthesized as plastic, as processed as breakfast cereals, and as contrived as network news.

Ecocentric Productivity

Ecocentric productivity, on the other hand, is defined by ecologists as the creation of new organic matter by the process of photosynthesis. It bears little relation to anthropocentric focus on mechanical and industrial productivity. Ecocentric productivity is a measure of how much new growth occurs when light energy fuels the metabolic machinery of plants, which enables them to synthesize the new compounds and structures that make cells divide. It is measured by the amount of biomass generated by organisms occupying an ecosystem. In essence, ecocentric productivity is a measure of life. Bonnie Ora Sherk's *The Farm* and Helen and Newton Harrison's *Survival Piece* offer compelling counterpoints to Warhol's Factory. These eco art pioneers engage ecocentric productivity by creating living systems.

LONGEVITY: LAND ART (WALTER DE MARIA)

Unlike some land artists who allow their works to erode over time, Walter De Maria has ensured that his masterwork, *The Lightning Field* (1977), will endure forever. Furthermore, he has made certain that it will not only endure; it will maintain its pristine condition in perpetuity.[4] These guarantees are included in his contract with the work's funders. The stipulations



Walter De Maria | Lightning Field (day view) | 1977 A permanent earth sculpture, 400 stainless steel poles arranged in a grid array measuring 1 mile by 1 kilometer, average pole height 20 feet 7 inches | Quemado, New Mexico

PHOTO: JOHN CLIETT / CREDIT: © DIA ART FOUNDATION, NEW YORK / COURTESY DIA ART FOUNDATION, NEW YORK

are common in circumstances where a work of art can be protected while displayed in a climate-controlled exhibition venue and protected in a climate-controlled storage facility. That is not an option regarding *The Lightning Field*, which fulfills the definition of *land art* by existing in, and being inextricably linked to, the landscape. *The Lightning Field* is situated outdoors on a remote desert plateau near Quemado, New Mexico. It is, therefore, subjected to perpetual disturbance by sunshine, wind, rain, heat, frost, solar flares, microbes, plants, animals, humans, and most particularly, lightning.

The flip side of choosing an outdoor context was rejecting art's association with status, entertainment, and investment, the trio of characteristics promoted by commercial art galleries. Furthermore, galleries were too confining to accommodate the grandiose gestures envisioned by land artists who were committed to leaving humanity's mark upon the earth.

The geometrical elegance of *The Lightning Field* is a product of 400 polished stainless steel poles that De Maria had manufactured and delivered to the site. Each pole is 2 inches in diameter and averages 20½ feet tall. The poles are installed at regular 220-foot intervals to form a precise grid that stretches as far as the eye can see. Rectilinear geometry also characterizes their composite shape because the tops of the poles are aligned to produce a precise horizontal plane. The elementary nature of the form belies the complexity of its construction. Because the earth undulates, the height of each pole had to be individually calculated to produce a perfectly level plane. High-resolution stereo photographs, optical machines, laser transits, and electronic distance-measuring equipment enabled De Maria to fulfill the inviolable rules of right-angled geometry, contradicting the site's irregular topography.

Most monuments of human construction that endure through the ages survive as

Walter De Maria | Lightning Field (night view) | 1977 A permanent earth sculpture, 400 stainless steel poles arranged in a grid array measuring 1 mile by 1 kilometer, average pole height 20 feet 7 inches | Quemado, New Mexico

PHOTO: JOHN CLIETT / CREDIT: © DIA ART FOUNDATION, NEW YORK / COURTESY DIA ART FOUNDATION, NEW YORK

gradually weathering constructions or as ruins. This was not De Maria's vision of longevity. He devised three strategies to protect *The Lightning Field* from succumbing to wear and tear: durability, resistance, and restoration.

Durability was maximized by implementing the no-compromise engineering specifications devised by Robert Fosdick during the work's planning phase. Fosdick, who directed the construction, comments, "We've taken 120-mile-per-hour winds into consideration, as well as the soil of this area, the storms, everything we can think of. The only change we can expect to happen would be caused if the earth itself moved."[5]

Resistance dictated the choice of medium. Stainless steel is immune to the vulnerabilities that afflict most other materials. It does not chip, fade, or crack; it withstands heat, light, and moisture; it resists fungus, bacteria, and predators.

Restoration is still necessary, despite these precautions, because De Maria intentionally subjects his rods to their one vulnerability. Stainless steel melts at very high temperatures. As the title suggests, De Maria exposes his artwork to lightning, a meteorological force that has stirred terror in the hearts of humans since the beginning of time. Lightning produces temperatures hotter than the surface of the sun. Nonetheless, De Maria beckons lightning to strike his work of art. The payback that justifies this risk takes the form of emblematic and awe-inspiring images of the occasional lightning strikes. These photographs account for the landmark status of this land art project. They depict jagged bolts of electricity hurtling through the skies, illuminating the vast array of steel rods. The linearity and brilliance of lightning is thereby matched by the linearity and brilliance of the stainless steel poles. In this way, lightning's capricious fury appears balanced against the strict logic of human geometry.

In order to fulfill this vision time and again, restoration is included in the site's conservation protocols. Damaged poles are quickly replaced after each strike, returning the work to geometric and material perfection. This guarantee is a profound cultural signifier.

Anthropocentric Longevity

Anthropocentric longevity is expressed as human strategies designed to preserve desirable conditions despite perpetual incursions and assaults by ecosystem forces. De Maria provides a compelling example of human willfulness by pitting the grid (the symbol of humanity's logic) against lightning (the symbol of the almighty force of nature) and then ensuring his work's survival. *The Lightning Field's* defenses against decay and damage confirm the anthropocentric values that extend throughout contemporary culture. Such defiance of ecosystem dynamics also motivates the manufacturers of wood preservatives, food stabilizers, rust retardants, Botox, cryogenics, fluoride treatments, and climate-controlled environments for the storage of art.

Ecocentric Longevity

Ecocentric longevity promotes continuity with the dynamic flux of interacting systems, in contrast to the static principle of endurance espoused by anthropocentric longevity. Ecocentric longevity is known as sustainability. Systems that persist even as individual components die or disappear are sustainable. They remain vital and productive over time by adapting to unanticipated changes. Walter De Maria's contemporary, Alan Sonfist, achieved status as an eco art pioneer by manifesting longevity in the forest he planted as an art project. His dynamic artwork will persist even as nonliving entities naturally accrete, erode, disperse, and dissolve and as living entities grow, die, decompose, evolve, and mutate.

PERSPECTIVE: CONCEPTUAL ART (ON KAWARA)

Perspective is the relationship that persons or cultures form with components of their surroundings. Landscape painters typically evoke their perspectives through aesthetic interpretations of the scenes they observe. Their perspectives can be distanced or immersive, skewed or frontal, oppositional or sympathetic, utilitarian or reverential. Such perspectives are irrelevant to On Kawara's conceptual art practice. His depiction of landscape includes only what he knows, not what he feels or perceives. For this reason he banishes inspiration from his creative process because it is momentary, observation because it is unreliable, sensuality because it is personal, and emotion because it is volatile. Kawara trades all of these appealing components of landscape painting to visualize a site's irrefutable location as prescribed by longitude and latitude, a rational scheme that imposes a grid of equal units upon the irregular complexities of the planet's land masses and water bodies. Latitude lines are equally spaced and parallel to the equator. Longitude lines are equally spaced and measure distances east and west. *Location* (1965) is such a painted landscape. It does not depict topographic or geological formations, nor weather and season, nor flora and fauna. Instead, Kawara reconfigures the landscape-painting tradition to epitomize conceptual objectivity. *Location* fulfills its title because the painted image depicts the numbers and letters that pinpoint an exact position. LAT.31°25'N and LONG.8°41'E denotes a remote region of the Sahara devoid of sentiment and history.

Objectivity also determines Kawara's style and composition. He avoids the whims of

On Kawara | Location | 1965 Lat. 31°25'N, Long. 8°41'E | Acrylic on canvas | 32.9" × 37.9"

PHOTO: PETER COX, EINDHOVEN, THE NETHERLANDS / COURTESY COLLECTION VAN ABBEMUSEUM, EINDHOVEN, THE NETHERLANDS

mood and taste by painting the numbers and letters in pure white upon a uniform dark green ground, presenting the text in standard Futura typeface, simplifying the composition to two horizontal lines centered between the top and the bottom of the canvas, and employing a methodical painting process undertaken with a predetermined result.

As a reflection of contemporary "perspectives" on the environment, longitude and latitude are culturally significant since they are situated in relation to the equinox and solstice. As such, they apply the remote perspective of the sun to places on the Earth. Thus, when humans use that latitude/longitude grid to answer the question, Where am I?, the answer is found by turning their backs to the earth and looking toward the sun for spatial markers. Recent Global Positioning System technologies and geographic information systems are referred to as "remote" because they, too, promote such emotional distancing.

Nonetheless as a manifestation of human perspective on the environment, Kawara's revision is more an extension of the landscape-painting tradition than a radical innovation. Like other landscape painters, he simplifies nature's inherent complexity, halts the actions of dynamic Earth systems, and ignores their role in humanity's survival. While his landscapes eliminate aesthetic stimulation and vicarious emotional release, they still present the environment as painted representations designed for contemplation.

Anthropocentric Perspective

Kawara's representation of a landscape is anthropocentric because it relies upon an abstract notational system invented by humans to benefit humans in navigating and communicating across the globe, and it disregards the inherent qualities of the location—its textures, shapes, colors, sounds, smells, temperature, humidity, and more. *Location* envisions the dissociated perspective of the many contemporary systems that use numbers to indicate places—zip codes, area codes, transportation routes, and so on. Kawara's version of a landscape encapsulates these aspects of contemporary perspectives.

Ecocentric Perspective

The word *landscape* is absent from ecocentric considerations because painted representations disregard the components of ecosystems that enable them to function: drainage patterns, ranges, biotic regions. They also ignore the interactions occurring within and among rivers, shorelines, mountain ranges, and meadows. These elements of the planet's locations are included in ecological terms like *watershed, habitat,* and *biome*. Such terminology considers locations according to their ability to provide resources, manage wastes, and perform dozens of additional services that determine the destinies of their populations. Joseph Beuys, Allan Kaprow, and Frans Krajcberg are among the eco art pioneers whose works embody the holistic character of ecocentric perspectives not indicated by the anthropocentric term *landscape*.

CONCLUSION

Nature is defined as the material world surrounding humankind and existing independently of human activities. This dictionary-like definition suggests that humans don't belong to nature. When humans think of themselves anthropocentrically, as outsiders, they grant themselves the leeway to approach nature as a medium of exchange, a source of wealth, a repository of resources, and a depository for waste. Separateness from nature is viewed as a sign of progress and a mark of civilization.

From an ecocentric perspective, however, the exclusion of humans from nature can justify behaviors that disrupt nature's balance and resilience. Many eco artists apply their communication and visualization skills to expand the definition of *nature* by incorporating human populations, all human technologies, and all the products of their imaginations.

While anthropocentrism and ecocentrism represent divergent worldviews, they are not irreconcilable. Approaches that privilege human-to-human communications and those that integrate nonhuman entities are both included in the toolbox of Twenty-First-Century humans. They may be appropriated separately or integrated, as when ecocentric strategies incorporate human perspectives and when anthropocentric behaviors attend to nonhuman and nonliving components of the environment. Eco artists are experimenting with varied proportions, introducing new recipes to accomplish the ongoing tasks of survival within conditions that are morphing rapidly, intensively, concurrently, and ubiquitously.

NOTES

1 Interview with G.R. Swenson, *Art News*, November 1963: 117.

2 http://www.gallerywarhol.com/andy-warhol-flowers-1970-FS-II.66.htm.

3 The image was taken by nature photographer Patricia Caulfield.

4 Support for maintaining and operating *The Lightning Field* is provided in part by an endowment established by Ray A. Graham III and Lannan Foundation. Support toward the permanent preservation of the undeveloped grasslands surrounding *The Lightning Field* was provided by Dia's board of trustees, Governor Bill Richardson and the State of New Mexico, Helen Winkler Fosdick, and Gucci.

5 http://www.sfaol.com/mccord/lightning.html.

ECO: Ecological Operatives

Introduction

What Is Ecology?
What Is Environmentalism?

ART HAS PERFORMED an impressive array of services over the course of human history. It has elevated the stature of leaders, instilled courage to march into battle, inspired piety before gods, celebrated the bounty of the harvest, warned against evil, evoked rapture, and on and on. Today, this impressive list of functions is being extended to attend to the current and future conditions of the planet's waters, soils, atmosphere, and living populations. Some of the creators of these works of art follow the scrupulous scientific methods of ecology; others who behave as advocates, critics, and protestors are proponents of environmentalism. Both explore the fundamental relationships that form the basis of eco art.

Ecologists study the distribution and abundance of living organisms and their interactions with each other and with the nonliving environment. This classical definition of ecology was devised in 1873 by Ernst Haeckel, an eminent biologist, philosopher, physician, and artist. Haeckel's bare-bones definition requires supplementing to convey the uniquely expansive scope of this scientific discipline. For instance, *distribution* includes the oceans, hydrothermal vents, glaciers, vernal pools, intestinal tracts, and every other location on the globe where life survives. *Abundance of living organisms* encompasses over 1.7 million species that have been named and countless more that have yet to be identified. Each species is composed of entire populations, whether of algae, fungi, amphibians, insects, plants, birds, or mammals. Likewise, *interaction* accounts for a broad range of behaviors that include reproducing, migrating, defending, creating shelter, capturing energy, processing waste, and even decomposing. The *nonliving environment* is no less extensive, because it includes energy as well as all forms of inert matter. Even the word *study* must be clarified to distinguish this discipline from scientific pursuits that remove objects being researched from the variability and complexity of normal conditions and relocate them within controlled settings. Ecological study avoids fragmenting systems, isolating phenomena, reducing multiplicity, and suspending time.

Environmentalists, in contrast, contribute attitudes, opinions, and priorities to the verifiable information provided by ecologists. They are at liberty to relate to the Earth's systems by celebrating its splendor, healing its wounds, bolstering its resilience, managing its resources, mimicking its efficiencies, lamenting its infirmities, and the many alternatives evoked by the human imagination. Environmentalism was catalyzed by a convergence of events in the 1960s, beginning with the publication of *Silent Spring* by Rachel Carson. This landmark book unnerved an entire generation by presenting evidence that human activities were causing soils to become infertile, rain to acidify, water to become contaminated, and species to become extinct. Her alarming message was reinforced by a succession of events: people died from extreme air pollution,[1] a chemical-laced river caught fire,[2] and massive oil

spills endangered wildlife and habitats.[3] The environmental movement in the United States was officially launched in April 1970 when Congress declared the first Earth Day and then established the Environmental Protection Agency in December of that year. A decade later, however, the movement became stalled by the Reagan administration's opposition to environmental causes, and then by the Clinton administration whose pro-environmental stance had the ironic effect of discouraging citizen activists. It was not until there was evidence of melting ice caps, and back-to-back horrific hurricane seasons in 2004–2005,[4] that planetary conditions rekindled the environmental movement.

NOTES

1 It was reported that 750 people died of smog in London in 1962, and 80 died in 1965 in New York City when a weather inversion created a four-day air pollution incident there.

2 On June 22, 1969, the Cuyahoga River burst into flames reportedly five stories high due to oil and chemical pollution.

3 The *Torrey Canyon* oil tanker crashed off the coast of England in 1967, spilling over 29 million gallons of oil on the coastlines of England and France. An oil well blowout spilled 235,000 gallons of oil that covered 30 miles of beach near Santa Barbara, California, with tar in 1969.

4 2004 was beset with a series of massive hurricanes, all topped in 2005 by Hurricane Katrina, one of the most devastating hurricanes on record in the United States.

Eco Art Themes

THE MENU OF ECO ART THEMES includes fossil fuel dependence, energy conservation, land use, rainwater harvesting, alternative energy, deforestation, extinctions, manufacturing protocols, mining, erosion, loss of topsoil, waste management, herbicides, pesticides, genetically modified crops, oil spills, overharvesting of fish and game, draining of wetlands, acid rain, overpopulation, genetic manipulation, consumerism, monoculture farming, toxic waste, irrigation, introduced species, carbon dioxide emissions, heavy metal accumulations, water contamination, ozone depletion, climate change, smog, species loss, local production, biomimicry, loss of habitat, privatization of natural resources, rights of indigenous peoples, soil contamination, traffic congestion, edible weeds, global warming, bioengineering, desertification, sustainability, radioactive waste, recycling, free trade, mutations, ecofeminism, remediation, restoration, revitalization, preservation, composting, up-scaling, environmental legislation, green architecture, environmental education, organic gardening, hydroponic gardening, urban gardening, and community-sponsored agriculture, to name a few. All these subjects are rooted in real-world conditions that yield consequential outcomes. All can be presented in terms of recorded histories, observable presents, and projected futures. All depend upon research. All are applicable to political policies, manufacturing protocols, lifestyle patterns, ethical quandaries, and cultural expressions.

These themes multiply when contrasting opinions about them are added to the list. Innovations may be honored for accomplishing their intended roles, for example, or derided for their dubious outcomes. Here are some examples:

- Agricultural methods that boost crop yields but exhaust soils and contaminate water
- Technologies that enhance mobility, productivity, communication, comfort, and pleasure but release toxic emissions
- Material abundance that provides luxuries but clogs landfills
- Advanced medicinal regimens that manage diseases but increase resistant bacteria
- Extraction methods that increase output but threaten the resilience of Earth systems

The copious thematic possibilities that introduce this essay were all gleaned from the last four percent of the time that has lapsed since *Homo sapiens* first stood upright and began striding across the Earth. This brief period is crammed with an astounding succession of innovations: agriculture, irrigation, writing, architecture, mathematics, religion, urban planning, metallurgy, trade, money, printing, firearms, combustion engines, nuclear power, eBay, space probes, instant messaging, reggae music, life insurance, and yoga spas.

The three- or four-billion-year history of prehuman forms of life on Earth serves as a

lengthy prelude to the evolution of humans. It offers valuable lessons for societies that are inclined toward gulping, grabbing, and guzzling. This is because the temporal enormity of prehuman history demonstrates that plant life did not emerge to feed hungry humans, nor did oxygen originate to support human life, nor did fossils accumulate to power human machines. Ultimately, it proves that humans are dispensable to the biosphere, while the biosphere is indispensable for human survival.

Artists are among the many environmentalists who are scrutinizing humanity's epic expedition on the Earth, weighing each breakthrough against the inadvertent breakdown that may result. The baseline for becoming an eco artist, therefore, entails selecting a theme from within this gaping span of time. Like the process of creating a map, this selection process isolates a component of the Earth's living and nonliving environment. An all-inclusive artwork would be as incomprehensible as a map that simultaneously described roads in Albuquerque, the topography of the African continent, constellations of stars, and tourist destinations in the Champagne Valley.

In order to narrow the field, however, it is first necessary to grasp the vast terrain that ecological and environmental concerns occupy. Options abound. The process of deciding which theme to address may be methodical or intuitive, but in the end it answers two essential questions:

1. Which of these thematic possibilities captivates my attention and inspires my creativity?
2. Which eco theme utilizes my current knowledge and capabilities, or my ability to gather information and develop skills needed to convey this theme?

A bank of super computers would be required to examine the innumerable thematic choices that appear on this list. Instead of attempting this unwieldy undertaking, the following text provides a synopsis of ecological concepts that are so foundational they can accommodate numerous thematic issues. The section for each concept is introduced by an outline of the basic ecological principles relevant to it. The section concludes by enumerating some thematic possibilities the concept suggests.

ECOLOGY: HOME ON EARTH

The *home* referred to in ecology is not composed of huts, cottages, apartments, mansions, nests, dens, or any other lodging. It consists of the entire planet that serves as the home for all living organisms of Earth. This concept can be traced to the origin of the word *ecology*, which is the Greek word *oikos*, meaning *dwelling place*. Over time, *Ökologie* was coined in Germany and became *ecology* in English. While ecologists investigate the functioning of this eco home, environmentalists apply home-care regimes to ecosystems and their human and nonhuman residents. This expanded definition of *home* radically transposes the concept of a stable, self-supporting structure enclosing its residents. To ecologists, home is a vast zone of dynamic, interdependent interactions.

The prefix *dom-*[1] reveals the profound transformation of cultural values that ecology entails. *Domicile* means *house*. But *dom-* also provides the root for the word *dominate*, as when people *dom*esticate a species and *dom*ineer its systems to gain *dom*inion over their environments and claim them as their *dom*ains. The alternative to the propensity to command the systems of the Earth is contained in the prefix *eco-*. *Eco*centric persons are home centered, home involved, and home serving. Their satisfaction is supplied by relationships that extend beyond human-to-human exchanges; they encompass trees, mosses, minerals, sunlight, insects, microbes, soil, and oceans.

Environmentalists often protest examples of human behaviors described by using words beginning with *dom-*. They hope to replace these actions and attitudes with those that comply with eco considerations. Together, they provide a rich territory for art theme explorations.

Ecology offers three variants of *home*: *habitat* refers to place, *range* refers to distance, and *niche* refers to behavior.

HABITAT

Every form of life is married to a context. Divorce is not an option. Habitats sustain life by providing resources to nourish and maintain the body's functions, to build shelter, and to manage wastes. These resources may consist of nonliving substances such as water, sunlight, minerals, oxygen, and carbon dioxide; they are referred to as abiotic. Other resources derive from living and dead microorganisms, plants, animals, and their remains; these are known as biotic.

Habitats are not always reliable storehouses of provisions. They are only hospitable if they offer appropriate resources in appropriate quantities for the populations that are in residence. Acorns, for example, are poisonous for horses but nutritious for pigs, deer, and bears. Likewise, an abundance of water allows frogs to thrive but rabbits to perish. Similarly, for any organism to survive, the quantity and nature of harmful conditions must exist at levels that it can overcome by fighting or learning new behaviors or evolving new traits, can avoid by fleeing or hiding or camouflaging, or can tolerate with antibodies or diet change or protective coverings. Immediate threats are posed by predators, competitors, parasites, and poisons. Eventual threats derive from plate tectonics, climate change, and sunspot activity.

Populations are not merely passive recipients of their habitat's bounties and dangers. Living entities contribute to fluctuations in the habitat's supplies of resources—either diminishing its vitality or enhancing it—by depositing wastes, consuming plants, casting shadows, compressing soil, constructing shelters, reproducing, and so forth. Thus, shaping habitat and being shaped by it are continuous and simultaneous for all organisms on Earth.

Humans and Habitat

Of all the dangers confronting habitats, the greatest threat may be posed by the human species. History provides disturbing evidence of humanity's debilitating effects upon its eco home. In the past, such behaviors were mostly confined to unsustainable agricultural practices and excessive logging/fishing/hunting. The current list of destructive actions has expanded, escalated, compounded, and proliferated. It includes, for example, radioactive waste, the release of bioengineered organisms, and mountaintop removal. Small-scale activities like mowing lawns and drinking bottled water contribute to habitat debasement as well as large-scale installations like coal-fired power plants. However, humanity's toll on habitats is not confined to such practices. Even if everyone pledged to stop driving cars, unplug their gadgets, and compost their waste, humans would still stress the Earth's habitats as never before. This is because keeping seven billion of us alive imposes unprecedented demands upon habitats' capacities to produce resources and manage wastes.

Humanity's impact on habitats provides manifold thematic opportunities for artists. Besides addressing the spectrum of behaviors that impoverish habitats, artists can promote strategies that enhance habitat vitality through conservation measures, recycling strategies, technologies that improve productivity and efficiency, or invention of sustainable approaches.

RANGE

Range is the physical area where a species actually lives. The ranges of most plants and animals are determined by the availability of resources that meet their life requirements within a geographic area. It is small if required resources are plentiful. However, if an endangering shift occurs, organisms are confronted with an ultimatum—they expand their range or migrate to a more congenial location, or they die. Disturbances that compel these alternatives can originate from pests, disease, fire, flooding, wind, contamination, precipitation, introduced species, erosion, and so forth. Climate change seems to be presenting species across the globe with range-related life-and-death dilemmas. Plants, animals, microbes, farmers, vacationers, and scientists are among the organisms that may be scrambling to establish new ranges if and when glaciers melt and waters rise.

Because animals creep, crawl, fly, swim, run, leap, walk, gallop, and saunter, they are able to expand their ranges. However, their mobility is increasingly obstructed by cities and highways that threaten their survivability. Plants, on the other hand, perpetuate their species over a broad range only if their seeds scatter or their roots send up new shoots. Individual plants, however, do not have this option. They are literally rooted in place. This means that their ranges are bounded by how high and wide their leaves pursue the sun, and how deep and wide their roots penetrate the soil. If habitat conditions change, the survival of the species depends on whether seeds are dispersed to more suitable habitats.

Humans and Range

We humans are not inclined to forgo necessities or pleasures simply because they exist outside of the immediate zip codes. Due to our capacity to import goods and export wastes, humanity's range is global. Average citizens enjoy the output of factories in China, forests in Oregon, ranches in Australia, cornfields in Iowa, copper mines in Brazil, lagoons of Thailand, and oil wells in Alaska. An advertisement for MCI serves as a fitting motto for the global dimensions of human ranges: "The world is our home."[2]

Where people live does not determine what they consume, nor does where they live depend upon a location's rainfall, temperature, and soil conditions. Technologies that produce life-sustaining conditions enable us to frolic in Las Vegas, sip beer in the Antarctic, and take naps in outer space.

Eco art themes can be garnered from existing conditions determining range, as well as those that are anticipated. Current predictions of the necessity to expand humanity's range of occupation are based upon escalating human populations and climate change. It may not be long before rockets powered for escape velocity will be launched on adventuresome range-seeking missions, exploring places for humans to live beyond the envelope of Earth's atmosphere.

NICHE

Niche refers to the activities performed by an organism or population within its habitat. Niche studies seek answers to two essential questions: How do organisms glean available resources for their survival? How do organisms defend themselves against competitors, predators, parasites, and pathogens?

Niche strategies that apply to animals include building nests, climbing trees, hiding, setting traps, fighting, and growling at humans. Those that apply to plants include poisons, aromas, camouflage, producing thistles, attracting the enemy of your enemy, and absorbing light energy. For humans, answers might include surfing the Internet for data, mining valuable minerals, and producing medicine, guns, vitamins, and toilets.

Yet these strategies account for only half of the niche equation. Besides gleaning resources and developing defensive strategies, species must maintain the vitality of their habitats. Niche occupation vitalizes a habitat when, for example, pioneer species improve soil, red algae works with coral to build reefs, and fungi recycle plant detritus. However, species that reproduce successfully can also fail the niche test if they compromise the health of their habitat. Invasive plants or animals, for instance, can reproduce so prolifically that they usurp indigenous species and deplete the territory's biodiversity.

Humans and Niche

Soaring human populations provide evidence that the human animal's numerous niche schemes have been remarkably successful. Early humans established the ongoing trend of inventing niche technologies when they learned to forage on the African savanna and then domesticated fire and chiseled flint into blades. These technologies have been continually bolstered by learned and socially transmitted behavior modifiers. Our inventory of tools includes ever more powerful hardware to mine resources and software to mine data. Meanwhile, demands for energy, consumption of resources, and production of damaging by-products escalate. The question now being posed by environmentalists is whether humanity's current niche construction strategies alter the environment to such an extent that they might ultimately decrease our chances of survival.

Concerned citizens are comparing humanity's current niche occupation to a hostile takeover, not a triumph. They are seeking niche roles in which humans, as rational creatures, devise and adapt complementary relationships among members of their own and other species. Eco artists may join this endeavor by devising niche roles for humans that sustain themselves and their fellow Earthlings.

SYSTEMS

There is no straightforward way to describe a system, which indicates its primary characteristic. Systems are complex. Although *system* can be defined as an assemblage of elements that form a composite unit, a system simultaneously has embedded subsystems and is embraced by supersystems that continuously effect and are affected by each other.

Living systems are self-governing and interdependent. Their existence depends upon being equipped with some mechanisms that specialize in resisting change and other mechanisms that are designed to accommodate change. This is because maintaining constancy and permitting modification are equal imperatives for survival. An example of constancy

involves maintaining internal temperature when external temperatures vary. An example of modification entails expanding diet when food opportunities shrink. Furthermore, systems must exist in appropriate proportions so that their interconnections are harmonious. If all these conditions are met, a line of kinship extends between subsystems like our own digestive tracts and supersystems like the biosphere. Violating this proportion and harmony unravels the mutuality that supports individuals and entire populations. The disruption of any part threatens the whole.

The word *closed* describes systems in which matter neither enters nor leaves the system; only energy is exchanged, for example as heat or work. Systems are *open* if both matter and energy enter and exit. Consider a house as a closed system. It would have no pipes connecting to a water supply and no need for a driveway. Air would not seep through the cracks, trash would not be deposited on the curb, groceries would not enter, and a contribution to the church bake sale would not exit. A house would only be a closed system if nothing entered except energy, whether as electricity fed through a grid or sunlight streaming through the windows. This analogy applies to our planetary home, which is considered *closed* by scientists who focus exclusively on heat escaping from our atmosphere and solar energy streaming in, but it is referred to as *open* by scientists who emphasize the tons of matter from comets that bombard the surface of the Earth each day.

Many cultures have conceived of their earthly home as a system composed of two pairs of primary elements: stone and air, water and fire. This hallowed concept did not acknowledge energy entering the system from the sun. As a result, the many processes that can be attributed to infusions of solar energy were unexplainable. Such mysteries as the existence of life, evaporation, germination, and rain were credited to supernatural entities whose favor was considered essential to life and prosperity.

Humans and Systems

Humans are a collection of systems. They are composed of reproductive, digestive, muscular, circulatory, and many additional systems. Humans also create systems. The systems they create can be mechanical, electronic, financial, political, religious, military, aesthetic, and so forth. Each of these created systems verifies the human brain's remarkable capacity to organize a world that might otherwise appear to be a chaotic conglomeration of phenomena and formations. Computer technologies are recent additions to humanity's list of created systems. They not only perform an unprecedented range of tasks, they augment humanity's ability to process information, think abstractly, discern patterns, and anticipate outcomes—the prerequisites for inventing ever more intricate systems.

Environmentalists are pooling their cognitive capacities to design systems that emulate ecosystem design efficiencies. Known as biomimicry, this endeavor comprises a great repository of thematic options for eco artists. Artists addressing energy efficiency, for example, might streamline air and fluid movement by aligning with the shape of least resistance in the systems of the universe. Unlike the straight line—the shape that prevails throughout current technological systems—it is a logarithmic spiral.

ENERGY

The sun's energy is trapped by plants, used, and then dispersed as heat. Because it is never cycled, organisms stay alive only if the Earth's energy supply is continually replenished. Ecologists identify two energy processes essential to life:

- Endothermic energy is being absorbed. During this additive process, atoms join into molecules and molecules become more complex, as in photosynthesis.
- Exothermic energy is being released. During this subtractive process, molecules dissociate, as in burning.

Humans and Energy

Energy production and consumption are common measures of standards of living. The analytic route that traces civilization from its inception until today discloses a consistent effort by people to exploit energy's potential to perform work. It also reveals the lengthening of humanity's energy supply line. Before the Industrial Revolution, people satisfied their energy quotients with local resources. They relied upon muscle power and fuels like peat, wood, vegetable starch, and animal fats. Once the Industrial Revolution became established, appetites for energy soared to power industrial machinery. Energy sources increased and supply lines lengthened. Coal was added to the energy menu. Then petroleum was included, and then nuclear sources. Now, nonrenewable fossil fuels are regularly piped across continents and shipped across oceans. They are being mined from deposits that lie miles beneath the Earth's crust and ocean's surface. Nuclear power is extracted from deep within the atomic structure of matter. Meanwhile, the range of fuels is still expanding to ensure supplies in the future. But availability does not equal usability. Energy sources must also be transferred, constrained, processed, and channeled, and their wastes must also be managed.

Environmentalists who acknowledge the effectiveness of these reaping technologies are rarely comforted by them. Establishing efficient, nonpolluting, reliable, inexpensive, renewable, and sustainable energy generation remains an unfulfilled goal. Attempts to satisfy these requirements may involve applying new technologies to such enduring energy sources as the sun, wind, geothermal heat sinks, and waves. Others enlist species like green algae that convert the sun's energy into a form that is usable by us, or split water molecules to release embedded energy. The goal of revising our energy budget and relocating our energy dependencies yields innumerable eco art themes.

LIFE/DEATH/EXTINCTION

For billions of years and throughout the planet's diverse ecosystems, life has been engaged in the continuous process of constructing itself from inputs of energy. In order to execute the fundamental functions of life building, molecules must be organized. But all life carries a death sentence. Even organisms that enjoy optimal living conditions cannot escape this inevitability. Thus, just as continuously, other life-forms are being dismantled. This process begins the instant that active manipulation of energy inputs is halted. Once the organism dies, energy dissipates. Its molecules are broken down and dispersed to be reassembled into new living entities. From an ecocentric perspective, the death of an organism is not an absolute finality, because the molecules of the dead organism don't vanish. They are re-sorted so that they are available for reuse within the vast arena of living forms. For this reason, the hypothetical manual that details ecosystem dynamics allots equal space to the accumulation of energy that increases organization and to the dissipation of energy that decreases organization.

Whereas death is not a terminus within an ecosystem, extinction does constitute an evolutionary and functional end point. Extinction occurs when an entire species ceases to contribute to the pulse of life on the planet. Billions of species have become extinct since the advent of life on the Earth three billion or more years ago. According to fossil records, only two to four percent of the species that have existed on Earth exist today.[3] The majority of these extinctions occurred prior to the evolution of humans. They were driven by cyclic climate change, catastrophic geologic events, and competition from better-adapted species.

Extinction/Biodiversity

Extinctions are proof of species' failure to adapt to environmental change. It follows that every entity that has ever lived is proof of a successful adaption to its particular environment. While the formulas of current evolutionary successes are contained in the gene pools of surviving species, the formulas of past evolutionary successes are contained in the gene pools of extinct species, even if they ultimately succumbed to inhospitable conditions. Thus, each time a species becomes extinct, an adaptation strategy is sacrificed.

When extinction occurs, an ecosystem does not merely lose a species; it also loses the services that the species performed. It may have benefited a system by capturing and storing energy, producing or decomposing organic material, controlling erosion, balancing populations, and conducting countless other useful functions. For this reason, extinctions compromise an ecosystem's ability to accommodate to temporary and enduring environmental changes. Diversified systems are significantly stronger, more productive, more stable, and more resistant to perturbations than simplified systems.

Humans and Extinction/Biodiversity

Recent extinction escalations are being traced to short-sighted activities of humans that cause long-term disruptions of habitats. This state is the unfortunate outcome of polluting the air, waters, and soils; introducing alien species; exploiting species; exhausting resources; and so forth. This trend can be traced back ten thousand years to the advent of agriculture. Cultivating crops means treating most native plants as weeds. Likewise, raising animals involves treating undomesticated animals as pests. Both practices reduce the inherent diversity of ecosystems. Currently, this trend is being accelerated to such an extent that it is known as the "sixth mass extinction" in the planet's history, the only one believed to be caused by the accumulated actions of a single species—humankind—and not a catastrophic geological or meteorological event. If mass murder of humans is called *genocide*, perhaps the mass murder of species by humans should be called *gene-ocide*.

Eco art themes can be derived by evoking extinct species, protecting endangered species, preserving species' habitats, or honoring diversity. Human impediments to biodiversity include the following:

- Introducing nonnative species that outcompete native species
- Overhunting, overfishing, overlogging, overmining
- Monoculture farming
- Paving
- Disrupting migration patterns
- Using pesticides and herbicides
- Dumping toxic waste
- Diverting water

Human strategies to enhance biodiversity include these:

- Planting green roofs and gardens
- Constructing parks, botanical gardens, zoos, and domestic gardens
- Promoting conservation initiatives and wildlife management projects
- Allowing plots of land in rural and urban areas to grow wild
- Remediating contaminated soil and reducing air pollution

Humans and Cultural Diversity

The term *cultural diversity* typically refers to the mixture of human cultural traditions represented in a specific region. As in biological diversity, each culture embodies a successful adaptation to some planetary condition. Because the Earth presents a multiplicity of short- and long-term conditions, cultures develop wide-ranging techniques for procreation, waste management, transportation, communication, governance, architecture, morality, art, and so forth. In this way, cultural diversity optimizes the range of adaptation strategies available to human populations. This asset is especially crucial when ecosystems are transforming, as under conditions of global warming.

Eco artists might find thematic inspiration among the ways humans hinder and improve cultural diversity, especially since the flexibility to achieve sustainability may best be derived from a mosaic of cultural traditions.

Human strategies that reduce cultural diversity include the following:

- Globalization
- Multinational corporations
- World trade organizations
- International monetary funds
- International distribution of films, technologies, music, clothing, and other consumer products

Human strategies that enhance cultural diversity include these:

- Legal mandates to protect and preserve indigenous traditions
- Economic incentives to protect and preserve discrete cultures
- Manufactured products and services that target niche markets
- Localization of crafts, religion, cuisine, architecture, holidays, etc.
- Neighborhood associations
- Regional strategies for growing vegetables, producing energy, making clothing, etc.
- Place-based education
- Decentralized news generation and distribution

SUSTAINABILITY AND CARRYING CAPACITY

Sustainability is a measure of long-term viability that is achieved when the disturbances that afflict a system are balanced by its compensating responses. Disturbances may be as subtle as a speck of dust on an eyelid or as dramatic as an earthquake. They may be as recurrent as lunar tides or as unanticipated as typhoons and meteor strikes.

Carrying capacity measures the limits of an ecosystem's ability to react to a disturbance. A system can be sustainable if three conditions are met: a response must have the opposite effect of the original disturbance; the intensity of a response must match the intensity of the original disturbance; the response must occur within a time frame that enables the system to adjust.

If tolerance levels are exceeded, an individual organism dies, a species becomes extinct, an ecosystem collapses. In the past, fatal disturbances took the form of spewing lava, crashing meteors, and other natural catastrophes. Civilization has updated this executioner's list by adding industrial pollution, genetically modified crops, and atomic fallout, for example.

Humans and Sustainability

Humans commit unsustainable practices when resources and goods are too inefficient to recycle, too contaminating to manage safely, too easily trashed. Such "cradle-to-grave" behaviors occur in domestic kitchens and artists' studios as well as industrial factories, wherever cycles of material use are ignored. "Cradle-to-cradle" practices, on the other hand, balance the use and replenishment of resources, as well as the generation and reuse of waste. Such sustainable solutions are often accomplished by mimicking the strategies that maintain vital ecosystems. Artists can pursue sustainability by avoiding, halting, reversing, and replacing those activities that can be fatal to species and ecosystems, or by bolstering a system's carrying capacity.

EVOLUTION AND MUTATION

Sustainability ensures permanence, but it does not imply stasis. On Earth, flux is omnipresent. Biologically, transformation is driven by evolution. With few exceptions, evolution modifies existing forms of life by progressing in the direction of greater complexity. The tailless, forward-facing, grasping, and imagining organisms known as *Homo sapiens* are presumed to have evolved from infinitesimal clusters of cells enclosed in membranes that comprised the first forms of life on Earth. Evolution, the change in a population's gene frequency over time, is often the product of mutation.

The words *mutate* and *mutant* manifest the duality of outcomes made possible by mutations. Changes that enhance chances of survival because they are suited to available conditions are acknowledged by synonyms for *mutate*: *accommodate, innovate,* and *regenerate*. Those that are detrimental and therefore reduce survivability are revealed by synonyms for *mutant*: *aberrant, deviant, grotesque*.

Humans and Evolution

Ingenuity and technological prowess have bolstered humanity's evolutionary advantages beyond spontaneous genetic transformations. The machines we engineer now perform superhuman feats of strength, dexterity, sensitivity, accuracy, endurance, and speed. The electronic devices we construct outperform the human brain's ability to sense, calculate, analyze, and store information. Robots combine these feats. In addition, physical infirmities are accommodated by pacemakers, joint replacements, robotic sensors, contact lenses, performance-enhancing drugs, hearing aids, organ transplants, and so forth. The futuristic character shared by this cache of innovations has progressed so far from evolutionary advances it is sometimes referred to as "post-human." These accomplishments might inspire eco artists to construct body- and mind-altering schemes that result in sustainable outcomes.

HUMANS AND HIERARCHY

Environmentalists of all persuasions are assessing the dividends reaped from the empowering strategies that enable humans to bolster their position on the hierarchy of living creatures, exceeding the peak niche granted by evolution. This ad hoc chorus of concern is seeking answers to the following questions: Have the record-breaking heights of human status made us lose sight of the numerous lower organisms that ensure our existence? Are we undermining chances for our own survival by abusing our base of support? Is there enough room at the top for escalating human populations?

These questions are instigating an interrogation of the current anthropocentric perception of human progress—the ability to control and harvest Earth resources to yield material comfort and convenience. An ecocentric alternative conceives of progress in terms of sustainability and responsibility. Artists might contribute to this reassessment by demonstrating that the "progressive" artist highlights the responsibilities associated with peak hierarchical status by choosing mediums and producing works of art that model sustainable material manipulations.

CONCLUSION

The ecological issues enumerated in this chapter infuse the themes that have received the attention of artists. No theme is exhausted, obsolete, or irrelevant. A representative sampling appears in this book. Many other themes await an artist's presentation and interpretation. Since none come equipped with a ready-made strategy for artistic expression, artists may direct their attention to accusers, defenders, culprits, or troubleshooters. They may behave like shepherds of the planet's life-forms, or technical designers of the planet's systems of production, managers of the planet's habitats, healers of the planet's infirmities, emissaries of the planet's wonders, avengers of the planet's spoilers, and curators of the planet's resources. These many topics and approaches share the goal of achieving the long-term health of the Earth's living systems, and they profit from artists' ingenuity, imagination, and vision.

NOTES

1 The prefix *dom-* is derived from the Latin word *domus*, meaning "house."
2 *New York Times*, November 10, 2003, C7.
3 http://www.encyclopedia.com/article-1G2-28301008 48/endangered-species.html.

ECO ART THEMES

Eco Art Aesthetics

A **GREAT TURNING POINT** in the history of Western art occurred in the Twentieth Century when art's association with beauty first received pummelings from the cubists, futurists, and Dadaists and then was practically exterminated by pop, conceptual, minimal, fluxus, art povera, happenings, and land artists. During these years, those who remained loyal to the goal of achieving beauty were often banished to the outposts of provincialism.

Aesthetics is commonly defined as the study of the mind and the emotions in relation to beauty. Yet aesthetics is a malleable term that has also relinquished its association with beauty to refer generally to the science of sensuous perception. In this regard it perpetuates the tradition by which discoveries in science influence both styles in art and the theories that support them. Renaissance perspective, for example, reflects Galileo's mathematics of motion; impressionist paint dabs coincide with scientific discoveries regarding color and light; cubism's fracturing of form parallels investigations into the atomic structure of matter. Currently, aesthetics is undergoing another revision to keep up with art's continuous reinvention of itself. Eco artists are devising a system of aesthetics to visualize how shapes, colors, and patterns distribute themselves within ecosystems.

The following essay demonstrates that eco-aesthetic investigation is conducted by delving beneath surfaces to discern nature's design efficiencies. Just as past artists dissected bodies to gain an understanding of anatomical structure and skeletal mechanics, artists are now scrutinizing ecosystems to discover how their forms create patterns, how these patterns congeal into constructions, how these constructions comprise networks, and how these networks function as systems.

MULTIPLICITY

The number 2 is the minimum state of multiplicity, yet it introduces manifold conditions that determine the dynamism of events on Earth. It is the numerical baseline that unleashes the drama inherent in relationships of all kinds. Without two of something there would be no separation or contrast, no pressure and friction, nor attraction and repulsion, creativity and conflict, newness and diversity, or likeness and difference. Physically, without at least two, there would be no light, no heat, and no energy. Conceptually, choice and opportunity are introduced by twos. However, the only time *two* actually describes the Earth is when it identifies two kinds of multiplicity: many of the same thing or many different kinds of things.

In the ecological world, *multiplicity* can be used to describe classifications, ecosystems, species, relationships, morphologies, scales, microorganisms, habitats, niches, ranges, fractals, adaptations, life spans, organisms, populations, communities, behaviors, extinctions, traits, environmental pressures, biomes, producers, consumers, decomposers, food webs, networks, vegetation, climate, metabolisms, and so forth.

The two forms of multiplicity characterize the contrasting aesthetic experiences that

exist in industrialized societies. Repetition, for example, prevails at the end of industrial assembly lines that produce uniform products and fulfill predetermined intentions. Artists can comment on the huge output of identical units that flood the marketplace by inducing the aesthetic response to repetition—monotony. Great variability, on the other hand, is an inherent component of commerce and popular media where a plethora of quick-paced stimuli compete to capture viewers' attentions. Psychologically, extreme variability generates confusion. Both boredom and confusion are uncomfortable states of being. They lie at far extremes from harmony, the pleasing arrangement of parts. While harmony is lacking in many environments designed by humans, it is easily discovered in outdoor locations like fields and deserts. Such settings avoid monotony because the shape of each object evolves out of adaptations to its exclusive microenvironment, which explains the uniqueness of waves, snowflakes, sunsets, mountains, clouds, frogs, fingerprints, blades of grass, and DNA. At the same time, confusion is reduced outdoors because the elements of an observed scene respond in unison to a given set of forces. The same winds, for example, cause tree limbs to twist, rocks to tumble, earth to erode, clouds to form, and waters to surge. Furthermore, shadows lengthen and shorten together because they are all synchronized with the Earth's rotations. Likewise, the hue and intensity of the light is consistent because it is determined by the weather and time of day.

Applying eco aesthetics to the creation of a work of art can reinforce an artist's theme. In this instance it may be accomplished by determining the intensity and type of multiplicity included in a composition.

LINES

We humans are so attuned to lines that our brains invent them even when they don't exist. Ancient peoples, for example, conceived of constellations by connecting the dots made of stars to resemble bears and dippers and bows. In contrast, the lines that are relevant to eco aesthetics are physical realities, not imaginary. From an ecological perspective, lines that emerge from a pen held by an artist are products of gravity (allows ink to run), viscosity (of the drawing medium), slope (of the application), flow (through the channel), and porosity (of the paper). Such material considerations demonstrate that drawn and painted lines in art are not merely representations. They manifest the same forces that govern rivers coursing through meadows.

OUTLINES: BORDERS

The ability to distinguish one object from another is a vital aid to survival. Navigating a world without such visual separations would be extremely challenging, which is why unified perceptions are typically reserved for extraordinary states like visions, dreams, and hallucinations. However, when eyes observe a scene, they receive a barrage of stimuli that resembles such undifferentiated states. This visual information consists of highlights, shadows, movement, textures, hues, and so on. It requires the active participation of the brain to discern the individual entities within this visual muddle. This is a remarkable feat because the eye is not aided by outlines. Indeed, there are no actual lines circumscribing objects in the real world. Outlines are inventions. They exist in art to define and separate shape. In the physical world, however, shape is produced by borders, not outlines.

Borders prevent the physical universe from blending into uniform consistency. Like outlines, they separate objects from their context. But unlike outlines, borders perform multiple additional functions. For living entities, for example, borders take the form of enclosing membranes. They not only separate one organism from its context, they prevent the internal organs from oozing out. Furthermore, borders protect the organism from being trampled, consumed, or attacked. Borders might also waterproof, insulate, and camouflage their owners. In addition, border functions might be augmented by shell, bark, scale, skin, feather, or fur. In eco aesthetics, borders replace outlines as producers of form.

Eco aesthetics also attends to the characteristics of borders. For example, organisms are neither secure nor safe if their borders resemble impenetrable fortresses. Borders surrounding organisms must be permeable to maintain life. For this reason they resemble busy multilane thoroughfares that provide access routes for such vital resources as air, nutrients, and fluids, and exit lanes for harmful substances like urine, sweat, carbon dioxide, and excess heat. Borders also transmit dispatches about ever-changing environmental conditions to the body's neural pathways. Permeable peripheries are just as essential for skyscrapers and cities, since they too depend upon energy and resources entering and wastes exiting the system.

Within eco aesthetics, the separating function of borders is also applied to states and conditions. The borders separating wet from dry, liquid from gas, tepid from boiling bear little relation to outlines since they are imprecise and gradual. Likewise, calendars may declare the instant that a new season begins, but in ecosystems winter gradually evolves into spring, and summer unfolds into autumn. Clocks may dictate the second a new day starts, but in actuality, night fades into dawn. Even the border transition between being alive and being dead is imprecise, since cells can remain viable long after the body they inhabit is declared dead.

Eco artists may still exploit the capacity of outlines to instruct and describe and clarify. But their other option is to emulate the shape-producing and condition-transitioning strategies discovered in functioning ecosystems.

LINES: TUBES

A line connects two points. When such lines exist in an ecosystem, as opposed to the surface of a drawing or painting, they typically take the form of elongated cylinders that function as tubes. In living entities these tubes include blood vessels, tree trunks, and bones. Those that are engineered include electrical lines, pipelines, and tunnels. Tubes on both lists function as conduits and connectors. Conduits channel oxygen, information, wastes, and so forth. Connectors join the nostrils to the lungs, the sensor to the brain, the toilet to the septic system, and so on. Because tubes maximize extension and minimize volume, they perform these essential functions with utmost efficiency, a core consideration within eco aesthetics.

SHAPES: SPHERES AND BOXES

Copernicus, the celebrated Sixteenth-Century astronomer, expressed why he believed the universe is shaped like spheres. "The reason is either that, of all forms, the sphere is the most perfect, needing no joint and being a complete whole, or that it is the most capacious of figures, best suited to enclose and retain all things, or even that all the separate parts of the

universe, I mean the sun, moon, planets, and stars, are seen to be this shape, or that wholes strive to be circumscribed by this boundary, as is apparent in drops of water and other fluid bodies when they seek to be self-contained."[1] Spheres have proliferated since Copernicus proclaimed their attributes. Ecologists situate every living entity in the biosphere that is imbedded in the hydrosphere (the Earth's liquid realm), the atmosphere (gaseous realm), and the lithosphere (outer crust). Astronomers have added the troposphere, stratosphere, mesosphere, thermosphere, and ionosphere.

Nonetheless, humans tend to construct environments that are replete with boxes. Four perpendicular walls contain most settings where we learn, work, sleep, eat, play, and relax. Four right angles form the containers for most of our possessions. When we die, we are placed inside a box, and another box marks our grave. Xbox, mailbox, cable box, batter's box, Unix box—boxes are ubiquitous in the contemporary environment. Three qualities they offer are missing from spheres: efficient means for packing, stability, and strength through rigidity.

Nonetheless, common phrases reveal that when we are trapped, we feel *cornered*, not curved. If we get stymied, we are *boxed in*, not sphered. Attempts to escape our predicaments are referred to as *thinking outside the box*, not in it. Self-improvement strategies entail striving to be *well rounded*, not well angled. When we are doing well, we say we are *on a roll*, not on a plane. And no one likes to be called *square*. These phrases reveal that we still share Copernicus's emotional connection to the sphere despite our culture's alliance with the cube. This alliance reveals the importance of industry and manufacturing as much as an alliance with the sphere connects us with life. Consider, for example, that conception transpires in seeds, eggs, and wombs, all of which are spherical. The social implications of curves and angles are core ingredients of eco-aesthetic analysis.

SPIRALS

The sun at the center of the solar system and our hearts at the center of our bodies are both hubs of spiral vortexes. Kernels, bracts, and needles reveal spiral patterns of growth for corn, pinecone, and cacti. Seashells, electrons, seaweed, hurricanes, blood, lava, fire, whirlpools, and galaxies all revolve in micro and macro cauldrons of spiral movement. As blueprints for beauty and functionality, spirals manifest the cosmos's great canon of design.

All spirals curl around a fixed point with distances that progress at regular intervals, but there are two manners by which they comply with this configuration. One manner is common among objects manufactured by humans, such as coils of rope, clock springs, and paper towel rolls; these expand in fixed increments. The other distinguishes myriad forms marked by growth and transformation, such as seashells, rams' horns, and ear cochleae; they expand exponentially from their source. These expanding spirals are seminal to biological organization. They are also prevalent among artistic representations of physical and spiritual transformation. Artists the world over tend to depict paths to heaven and descents to hell as spiral-shaped passages.

Because spirals constitute the path of least resistance, they are the natural shape of flowing matter. Modern technologies, however, tend to move things in straight lines. Overcoming resistance to this unnatural pattern requires energy inputs and machines to push things along. Fans, propellers, and engines accomplish straight-line movement. Bathtubs manifest these dual forms of movement. Water is pumped through straight pipes to arrive in the faucet, but it spirals when it flows freely down the drain. Eco aesthetics offers artists the opportunity to emulate the Earth's inherent pattern of efficient design—the spiral.

PROGRESSIONS

Divine harmonic proportion, sacred geometry, golden ratios—all these terms honor a particular progression of numbers in which each number is the sum of the two preceding numbers: 1, 1, 2, 3, 5, 8, 13, 21, 34, and so on. Because the sequence accelerates the degree of increase and proceeds infinitely, it forms an expanding spiral when the numbers are plotted. The esteem of this numerical phenomenon is well earned. Physically, the numbers constitute a universal law of progression. Metaphysically, they provide evidence of the interconnectedness of matter at all scales of being. The sequence is known as the Fibonacci numbers after Leonardo Fibonacci, who discovered it in the Thirteenth Century. However, the earliest known proprietors of this knowledge were the Egyptians, who embedded its secrets in the ground plans of their temples, believing it embodied the essence of beauty, harmony, and creation on Earth.

Fibonacci numbers can be retrieved from the shape of our DNA and the measurement of distant galaxies, the rate of radioactive decay and the growth of rabbit populations. Sunflowers manifest the sequence in the number of clockwise and counterclockwise spirals, which are always consecutive Fibonacci numbers such as 21 and 34, or 34 and 55. Furthermore, Fibonacci proportions prevail in such common human constructions as 2" x 3" light switches, 3" x 5" note cards, 8" x 13" legal pads, and such landmark buildings as the Greek Parthenon in Athens and the United Nations headquarters in New York City. But it is not necessary to go any further than your own hand to observe Fibonacci proportions. Each of your five fingers has three parts separated by two knuckles. This eco-aesthetic principle is particularly useful to artists who wish to contrast the dynamic progressions of living forms with the fixed progressions of most engineered products.

COMPLEXITY AND CHAOS

Ecosystem complexity challenges the version of reality described by Euclid, the renowned Greek mathematician who devised the model of the physical world in the Third Century BC that prevailed for centuries. Euclid asserted that the rational mind of humans harmonized with the rational state of the universe, which was, therefore, as logical as pure geometry. Paul Cézanne (1839–1906) confirmed this belief when he described the principle that inspired his paintings, "Everything in nature can be viewed in terms of cones, cylinders, and spheres." In contrast, it is multifaceted complexity that characterizes healthy ecosystems where continuous interactions occur within numerous, sporadic, evolving networks of causations. Eco aesthetics envisions the Earth as home to billions of organisms interacting with each other and responding to fluctuating conditions that emerge every microsecond on every micrometer of the globe.

Chaos is the sister of complexity. The difficulty of envisioning chaotic conditions does not indicate that a condition is tumultuous and haphazard. In ecology, situations are identified as chaotic when the human capacity to understand them is incomplete, thereby subverting predictability. Chaos occurs when causes are too small for humans to detect, too

vast to track, and/or too multiple to calculate. Naturally occurring examples of chaos include heart rhythms, fluid dynamics, electrical circuits, weather patterns, and the spread of disease. Human-made chaotic systems account for traffic patterns, public opinion, stock market activity, and even the onset of war.

Whereas geometric representations in art uphold faith in ordered simplicity, artists intent on representing an ecological version of reality acknowledge its complexity and chaos. They practice art in the manner of an ecologist by engaging the fluid intricacies of real-world conditions. Their efforts are as distinguishable from art conventions as ecologists' methods are distinguishable from the formalized research methodologies of other scientific disciplines. These methods involve simplifying the subjects of study by limiting data, dismantling systems, and isolating subjects of observation. Some eco artists also submit their work to real-world dynamic engagements. They express chaos by subjecting their artworks to the vagaries of ongoing physical events instead of attempting to beat the odds against uncertainty by controlling the outcome.

Alternatively, eco artists and ecologists may create simulations of ecosystem complexity through advanced computer technologies. Such ecological studies generate hypotheses and statistical projections, not absolute facts and predictions. In art, they tend to visualize invisible forces and processes.

FRACTALS

Meandering coastlines and clouds forming over the horizon cannot be described using the precise geometries envisioned by Euclid. However, scientists recently discovered that the unfathomable complexity of these and numerous other irregularly shaped entities is neither random nor unfathomable. They exhibit the orderly characteristics of a pattern because the shapes of their parts resemble the shapes of the whole. Patterns that repeat at different scales are called fractals.

Fractal shapes emerge from the bewildering complexity of Earthly shapes that are chaotic. One example is provided by the winding shapes of water coursing through a landscape. They are chaotic because they result from the simultaneous actions of water, heat, moon phases, erosion, evaporation, accretion, animal activity, and so forth. Nonetheless, trickles of water only a few centimeters wide resemble mighty rivers spanning continents. Fractal organization that exhibits such self-similarity can also be observed in broccoli, trees, galaxies, and brains. The repetitive patterning of these complex shapes at different scales accounts for fractals' dazzling appearance.

In addition to introducing a new form of patterning into the visual vocabulary of eco aesthetics, fractals introduce a new standard of measurement. This computing scheme is based upon complexity, not size. Thus, different answers can apply to the measurement of the same fractal form. For example, the circumference of a tree with rough bark is smaller if it is measured with a logger's tape than if it is measured by a two-inch caterpillar. Likewise, the caterpillar's measurement is smaller than the circumference measured by the tiny beetle. This is because the logger's tape skips from high point to high point along the rough surface of the bark, whereas insects travel farther as they move up and down these irregularities to circumnavigate the tree. Fractals demonstrate that no single measurement represents the "true" size of a complex object. The greater the complexity of the shape being measured, the more discrepancy exists using different scales of measurement.

Fractals are not merely curiosities that enrich eco aesthetics by introducing a new category of visual delight. Fractal patterning is being exploited by many new technologies: fractal antennae allow for broadband reception in a compact space; fractal fiber optics reduces distortion; fractal Internet traffic analysis facilitates Internet design; fractal mixers allow fluids to mix at low turbulence. For engineers, biologists, and artists alike, fractal concepts are extremely useful tools for extrapolating information between divergent levels of organization. For instance, through fractal analysis the dynamics of planetary systems might be deduced from the dynamics of molecules.

SCALE

Scales are slippery constructions. They indicate comparisons, not precise quantities. Because they measures degree, magnitude, and ratio, scales always exist in relation to context. Scales can be applied to physical characteristics like size, weight, distance, density, and duration. They pertain to conditions such as temperature, fragility, malleability, and conductivity. Scales can also be assigned to qualities like efficiency, impact, risk, beauty, and equilibrium. As a measure of relationship, scale is an important component of ecological investigations and eco-aesthetic decisions.

Humans' imaginations tend to delight in extremes of scale. The advances in science and technology making headlines tend to report such topics as intergalactic rocket probes and nanoexplorations of subatomic particles. Such explorations of the limits of the universe bypass the mundane scales of everyday life. In fact, the association of the average scales of our world with the commonplace, unimaginative, and dull is apparent in the connection between the word *mundane* and the Latin word *mundus*, meaning "world."

Ecology draws attention back from the extremes of scale and refocuses it on phenomena in our midst. Artists can reinforce ecology's appreciation of phenomena that exist at the scales of unaided human perceptions and unmediated physical interactions.

DYNAMISM

Stasis is an abstract concept that is absent on Earth. Flux rules. Weather is ephemeral. Season is recurrent. Climate evolves. Geological cycles are prolonged. Storms are erratic. Species evolve. Populations flush. Water encapsulates dynamism because it never rests. It travels in an endless cycle from the ocean, to the atmosphere, over the land surface, and back to the sea. Continual motion also applies to the Earth's crust, mantle, and core. Even the term *rock solid* is misleading. Earthquakes and volcanic eruptions provide dramatic evidence that tectonic plates of rock converge, collide, and diverge. Mountain building and ocean trenching are unobservable ever-changing occurrences.

The earliest occupants of the seas provide an epic example of Earth dynamism. They were primitive bacteria that thrived within a primeval soup of sulfurous waters. For ninety-five percent of the four billion years that life has existed, they were the only form of living entity on Earth. Still, stasis was not on Earth's agenda. These bacteria gradually exhausted supplies of carbon dioxide that was essential to their survival and replaced it with oxygen that was poisonous to them. The prolonged accumulation of their minute actions readied the planet to support oxygen-breathing organisms like you and me. The extinction of trillions of bacteria over the course of billions of years engineered the planet for life as

we know it. It is just as certain that what we know today will not be known to our distant descendants.

Artists practicing eco aesthetics can expand art's engagement with dynamism beyond painted or sculpted representation by incorporating actual changes within their artworks. Such changes may be inherent to the nature of their mediums, the result of environmental conditions, powered by machines, or instigated by the public. The evolution of these artworks does not necessarily end once the artist's direct engagement ceases.

STABILITY/FLEXIBILITY

That stability optimizes security is a widely held assumption that provides the template for many contemporary systems of governance, education, business, and religion. Structurally, this interpretation of stability tends to resemble a hierarchical pyramid in which authority is concentrated at the peak, communications proceed from the few to the many, decisions are generalized, conformity provides the measure of good conduct, and uniformity comprises the goal of production.

However, this template ensures security only if conditions are predictable, as when a precise task is being performed in an environment that is constant over long periods of time. Such conditions are common in factory production but conspicuously absent from climate, population densities, contagious diseases, and other phenomena characterized by fluctuations arising at random intervals.

Healthy ecosystems, however, are most productive when they function as if they have loose hinges, supple joints, and expandable struts. This flexibility enables them to take advantage of unforeseen opportunities, protect themselves from sudden threats, and adapt to unanticipated occurrences. It even grants them latitude to rewrite their own operating manuals. As such, ecosystems exhibit strategies for coping that have been refined over the course of millennia. These models indicate that stability is gained through flexibility, not rigidity.

The heart provides compelling evidence of this principle. Regular, periodic heart rhythms are optimal only in steady-state conditions. But in the ever-changing environments in which most animals live, vigor and longevity depend upon the heart's ability to beat irregularly.[2] The mechanisms controlling heart rates are intrinsically chaotic.

Online technologies used for banking, lending, shopping, reading news, swapping music, publishing, and communicating incorporate such flexibilities. Eco aesthetics enables artists to emulate them by creating systems that decentralize authority, permit multidirectional communications, and allow spontaneous transformations to occur.

SYSTEMS

Systems are functional groups of elements that are composed of multiple interacting parts. Existing on Earth does not offer the option of disassociating from systems. Humans live nested within biological, social, economic, climatic, geographic, religious, ethical, and many other types of systems. Formally, systems depend upon relationships. Temporally, systems involve change over time. Structurally, systems are complex. Quantitatively and qualitatively, systems depend upon multiplicity. Artistically, systems have infiltrated eco art aesthetics, sources of inspiration, ethical standards, material choices, and creative processes. They

conclude this essay because visualizing systems' complexities explains both the originating motive and the culminating goal of eco aesthetics.

NOTES

1 Nicolaus Copernicus, *On the Revolutions of the Heavenly Spheres* (Chapter One, Book I of VI, 1543).

2 "Irregular Heartbeat May Be Normal," *Nutrition Health Review*, Fall 1989. Accessed through Resource Library, FindArticles.com. http://findarticles.com/p/articles/mi_m0876/is_n52/ai_8542487/.

Eco Art Materials

ARTISTS TYPICALLY REFER to the physical component of their artworks as *medium*, capitalizing on the word's double meaning: medium is a physical substance through which an effect is produced, and it is also a person who conveys spiritual messages. Artists' mediums are, therefore, tangible forms of matter that serve as vehicles to express emotions, symbols, and concepts.

This essay asserts the timeliness of highlighting the physical material out of which art is produced. Consciously assessing the physical basis of art allows artists to express concern over the state of the Earth's ecosystems. Thus, in addition to communicating the expressiveness of medium, eco artists address the fact that art is constructed out of matter, its energies are stored in matter, and its processes are manifested in matter. This approach signals a distinct separation from "new media" that manipulate immaterial data through push-button technologies, keyboard operations, and computer-modeled visualizations.

The context for this reevaluation of the physical components of art originates in the markings of early humans that appear on bone, antler, and stone. Material manifestations reign as a distinguishing feature of subsequent art traditions: clay in Mexico, textiles in Vietnam, soapstone in Alaska, fresco in Italy, wood in Africa, porcelain in China, paint on canvas in Europe. In the first half of the Twentieth Century, European and American artists added found objects from the real world to the inventory of art interactions. In all of these versions, matter contributed aesthetic qualities (color, texture, transparency, shininess, etc.), structural possibilities (flexibility, viscosity, brittleness, stickiness, durability, etc.), and thematic content (elegance, rarity, banality, disgust, crudeness, etc.).

Currently, three new material options are being introduced by eco artists. One utilizes sap, pollen, feathers, bark, bone, branches, stones, and innumerable other ingredients that account for the wondrous storehouse of materiality on Earth. Another draws from a profusion of discarded and degraded manufactured materials. The third explores the array of living plants, microbes, and animals. Unlike the remote landscapes that appear on the screens of laptops, iPads, and televisions, eco artists are reclaiming the skills associated with engaging in direct interactions with the Earth's mineral, manufactured, and organic matter. They align art's expressive, narrative, and ethical significance with the physical components of experience.

All three categories of material exploration are motivated by concerns regarding the environmental impact associated with material use of all kinds. Eco artists are assigning as much significance to the material considerations of art as to its aesthetics and theme. Art's visibility and influence provides a privileged opportunity to address the impact of humanity's physical interactions upon the vitality of Earth.

Making material decisions from an ecocentric perspective means acknowledging that a finite stockpile of resources on the Earth comprises humanity's shared inheritance with all other forms of life. What we are and all we own are fabricated out of this common pool.

Even the molecules that comprise our bodies are merely on loan from the ecosystem. Living organisms depend upon the cycling of a shared inventory of raw materials to perpetuate life.

Yet history chronicles examples of humans disrupting these essential processes. Such interruptions generally fall into three categories:

- We increase a substance, such as carbon dioxide, exceeding the system's capacity to recapture it and maintain a balanced state.
- We decrease a resource, such as fish, by overexploitation, and water, by pollution.
- We create new materials such as Teflon, GORE-TEX, and polyester that exist outside the range of the recycling pathways that have evolved over millennia to manage wastes in ecosystems.

The material form of eco artworks represents the culmination of a process of interrogating eco art's environmental impact. Creating eco art, therefore, entails assessing each material option by asking these questions:

- Is it recycled, reused, restored, renewed, polluting, depleting, or keystone?
- Is the energy used to produce it renewable, polluting, local, or depleting?
- Are the wastes and leftovers reusable, beneficial, neutral, or toxic?
- What is its impact on the people who manufacture it and the ecosystems that generated it?

FOOTPRINTS

Footprints measured by environmentalists extend far beyond the toe and the heel of a foot. Ecological footprints measure material resources consumed, energy resources spent, and wastes generated. Footprint calculations compare human use of a resource and disposition of wastes to an ecosystem's ability to regenerate its resources and manage its wastes. This condition is known as its *carrying capacity*. If the use of a resource is supported by the enviroment within its carrying capacity, that practice is sustainable. If use results in permanent depletions of a resource or function, the practice is unsustainable. Footprints apply to nations, species, industries, populations, individuals, and art.

The footprints of works of art measure the environmental impacts of material acquisition, production, storage, crating, transportation, exhibition, promotion, maintenance, and final disposition. Applying such calculations to art raises doubts about spacious studios lavishly outfitted with energy-guzzling technologies, the assumption that monumental proportions are a measure of artistic significance, that it is ethical to lavish fragile artworks with resource-consuming and energy-expending conservation procedures.

All these art protocols perpetuate the expectation of affluence that arose during the first flush of industrial productivity. Eco artists respond to the current era's concern with the Earth's inability to support soaring human populations by demonstrating material accountability for all activities, including the production of art. While footprint considerations may limit artistic license, environmental responsibility does not constitute an impoverishment of creative opportunities. Every artist in this book demonstrates that there exists a vast depot

of material ingredients that account for a wondrous uniqueness of the planet we call home. They all await adoption by eco artists.

ECOLOGICAL MATERIALISM

Minimizing art's footprint tampers with the popular notion that artists' primary job is to express the *self*. Footprint-conscious artists downgrade the ego in order to upgrade the eco component of their creative practices. Jane Bennett, a professor of political theory at Johns Hopkins University, proposes a radical strategy to accomplish this cultural conversion. Bennett asserts that people need to be more materialistic, not less!

Bennett named this startling proposition "environmental materialism." She distinguishes it from materialism associated with the kind of consumerism that promotes relationships with material possessions, and may be described as "promiscuous" because they are casual, numerous, and superficial. Consumerism celebrates affordable abundance. It tolerates accelerated obsolescence, upgrades, quick turnovers, and accumulation.

Environmental materialism, on the other hand, involves mindful and purposeful relationships with the material environment. It is based upon "thing-power," the belief that even the common artifacts of daily use have significance.[1] According to Bennett, every thing has power because every material object belongs to the dense web that connects all living and nonliving components of the environment. Respect for things ensures that matter and energy are not exhausted or corrupted as they course through human cultures. Even a plastic bottle is the remarkable summation of resource refinement, engineering proficiency, and design expertise. Even a pinecone is an evolutionary marvel.

Bennett asserts that thing-power yields two positive results. One is enchantment, which she describes poetically as "a sense of having had one's nerves or circulation or concentration powers tuned up and recharged—a shot in the arm, a fleeting return to childlike excitement about life."[2] The other is prudence, which means good judgment in practical matters.[3] Her radical propositions can be applied to artists.

Enchantment

Standardized and anonymous materials manifest industrial and corporate efficiencies, but they offer meager installments of enchantment. Even water loses its allure if it flows predictably from a tap. Likewise, fuel from a pump, heat from a furnace, eggs from a carton, and paint colors squeezed from commercial tubes can all be re-enchanted through cognitive awareness of sources and sensual engagements with systems.

By evoking enchantment, eco artists affirm that the Earth does not merely consist of mute matter available to humans for plundering and exploitation. They stir enchantment by fostering delight regarding the material environment that is unrelated to consumption and possession. A prime example is art that honors the intricate web of responses that produce the statistical miracle known as "life."

Until recently, visual perception has provided art's version of enchantment by delighting the eye's ability to discern colors, shapes, and textures. Currently, many eco artists are extending the art audience's relationship with the physical environment by including material engagements derived from a profusion of attributes not detectable by vision: soft/hard, heavy/light, hot/cold, elastic/rigid, spongy/firm, strong/weak, pliable/stiff, and so on. Such multisensual interactions are powerful generators of material enchantment.

Prudence

The prudent aspect of ecological materialism involves assessing materials according to their current and long-term effects on humans, other species, water, air, soil, and weather. This means that artists' material choices are made with concern for immediate environmental impacts as well as for people they will never meet, places they will never visit, and outcomes they will never experience. Thus, prudence introduces new criteria to assess an artwork's merit. Beyond availability, compliance, and stability, it adds efficiency, renewability, and conservation.

ECO MATERIAL ATTRIBUTES

The materials available for adoption within the eco art avant-garde present such a vast inventory, providing a material assessment of each lies well beyond the realm of possibility within this text. Instead, pairs of characteristics that accompany five considerations of material choices are explored: manufacture, life, reactivity, degradability, and renewability. Together they comprise a periodic chart to guide material interactions in art that ensure enchantment and prudence.

Manufactured Materials Current manufactured materials are predominantly products of industrialized technologies that capitalize on automated production, mechanized processes, and increasingly, electronic controls. Such mechanization streamlines the transformation of raw resources into manufactured commodities, escalates the scale and efficiency of output, and churns out the material abundance many people currently enjoy.

However, contemporary manufacturing processes can also be blamed for many of the environmental predicaments that currently beset the planet. Jeremy Rifkin, an American economist, provides a compelling explanation of this predicament. In his book titled *Entropy*, Rifkin compares the energies and materials consumed by modern technology to its outputs. He discovered many examples of inefficient inputs and undesirable outputs that are credited for consumer abundance. Wasteful outputs, for example, include heat from fuel combustion, solid waste by-products from fabrication or extraction, and effluent discharge from factories. These wastes are rarely recycled or reused in modern production processes. Instead, industry depends on continual supplies of nonrenewable energy and resources. Furthermore, management of wastes is costly and often ineffective. Rifkin concludes that the modern industrial system is hurtling toward a non-sustainable destiny commonly known as "doom."

Manufacturers can implement the following protocols to minimize the footprints of their production methods:

- Fabricating new manufactured products using ingredients recycled from previous human use
- Fabricating new manufactured products with virgin resources that are generated sustainably
- Inventing more efficient technologies to manufacture materials
- Reducing the distances between where resources are gleaned, materials are produced, and products are used

Eco artists can adopt the following protocols in acquiring their materials to support manufacturing reforms:

- Repurposing used manufactured objects
- Dismantling discarded manufactured objects to harvest useful components
- Using overruns of manufacture that would normally be discarded
- Finding uses for stored manufactured items
- Finding uses for obsolete or discarded manufactured items

Nonmanufactured Materials Whereas goods that are the result of industrial production are predictable outcomes of being molded, poured, and stamped along conveyor belts, nonmanufactured materials are not predictable. Instead, they are characterized by infinite variability. There are several categories of nonmanufactured materials that are available for adoption by artists:

- Plants
- Plant parts: stem, leaf, root, shoot, pod, flower, seed, bark, needles, twigs, boughs, juice, sap, charcoal, gum, berries, cones, husks
- Animals
- Animal parts: feathers, bones, hooves, horns, fur, scales, shells
- Mineral elements: stone, metal, glass, water, sand, clay, air

Adopting nonmanufactured substances like plant and animal parts does not automatically guarantee eco materialism. The environmentally conscious act of selection entails discovering whether it produces harmful by-products, consumes non-sustainable ingredients, diminishes ecosystem resilience, utilizes exploitative labor practices, or depletes resources.

Life Art is generally created out of inert materials that are prized for their control, stability, and durability. Eco art introduces a dynamic alternative by adding the option of culturing life or partnering with life. The process of incorporating living entities into art is a complex and unpredictable affair that can be imagined as using paint that is capable of overflowing its container of its own accord, or canvases that can crawl along the studio floor, or brushes that get indigestion.

Lifeless Materials Some lifeless entities were always inert. Others were once alive. Some are manufactured by humans. Others exist without human intervention. Until recently, lifeless materials could not self-initiate actions; they responded to external influences only by accreting, melting, eroding, erupting, falling, drifting, dissolving, and so on. The qualifying phrase "until recently" acknowledges that smart materials are currently being engineered that are rendering past limitations obsolete. For example, engineers are designing "smart" textiles, an entirely new generation of Earthly matter that can cool their wearer when temperatures become uncomfortably hot or repair themselves when they become torn.

Living Materials When artists invite living entities into the repertoire of their interactions, the catalog of art production brims with new possibilities. Living materials can be plant or animal, old or young, endangered or abundant, dangerous or benign. They can be large or

microscopic, complex or simple, wild or domesticated, native or introduced, competitive or cooperative, sick or healthy, useful to humans or nuisances. Artists can participate in the creation and perpetuation of life by pruning, selecting, feeding, culling, breeding, grafting, cloning, and so forth. Living entities self-initiate actions by moving, reproducing, eating, drinking, excreting, breathing, and growing.

While nonliving entities are subject to conditions in the surrounding environment, living entities actively respond to their environment with the general goal of maintaining life. Two pairs of responses summarize these massively complex interactions:

- Responses to external stimuli are either products of learned behaviors or inherent and involuntary.
- Responses to external stimuli are either positive or negative. Positive stimuli attract organisms to life-sustaining resources and desirable conditions; for example, flowers seek light and flies seek rotting meat. Negative stimuli repel organisms away from conditions that are harmful to them; for example, deer flee forest fires and salmon avoid warm waters.

Biodegradable Materials Life resembles a multiservice industry. Its tasks include producing oxygen, recycling carbon dioxide, filtering waste, enriching soil, capturing and converting solar energy, and so forth. An often overlooked function of life is decomposing. All forms of life—and all the products that originate in living forms—are biodegradable. The *bio* that performs the job of *degrading* includes bacteria, fungi, worms, and insects. This sanitation crew breaks down complex material from discarded plant matter and animal corpses. It generates the simple compounds that green plants and other producers use to create new organic molecules. In this manner it supplies the nutrients that are distributed among the manifold biotic species that grace planet Earth.

Biological decomposition occurs without human intervention in forests, grasslands, jungles, and gardens, wherever dead organic matter collects. Composting is a human-induced scheme that intensifies the biodegrading process. It is undertaken to reduce pressure on landfills and produce fertile mediums for planting.

Nonbiodegradable Materials Yesterday's royalty could never have imagined the common materials that today's humans discard each day. These materials, concocted to augment power, comfort, and convenience, are created by engineers manipulating minute bits of matter by taking molecules apart and putting them back together. The new materials they devise exceed previous capacities to withstand heat, light, moisture, compaction, compression, percussion, microbes, breakage, and oxidation. Now many substances we throw away are practically impervious to change. They are expanding the age-old list of nonmanufactured products that are minimally degradable, such as stone, crystal, petrified wood, fossilized bone, sand, clay, and water.

Industrially manufactured nonbiodegradable materials are not necessarily blights on the environment. Their longevity becomes an asset when they are assigned a new function. Alternatively, they can be subjected to industrial recycling processes, as when plastic bottles are reused in textiles. This entails dismantling and re-mantling the chemistry that we humans so diligently engineered into existence.

Industrial cycling involves assembling, sorting, transporting, compacting, shipping, and manufacturing before the substances can be returned to the economic stream of production and consumption. For this reason, not all nonbiodegradable manufactured materials are good candidates for industrial recycling. Some degrade in quality when they are recycled; some consume excessive resources during recycling; some are so heavy they are costly to transport; some produce harmful by-products during recycling.

Reactive/Nonreactive Materials

Reactivity is the tendency of materials to undergo chemical change. All materials are subject to external influences. Reactivity measures the tempo of change from fast to slow, not its presence and absence. Materials like ice, paper, and alcohol are highly reactive. But even iron rusts, steel expands and contracts, and stone dissolves.

Humans have devised many strategies to manage reactivity. Some strategies intensify reactivity, as when the military develops materials that ignite, split, and explode as warheads. Other strategies suppress reactivity, such as adding preservatives to bread.

Some eco artists demonstrate consonance with ecosystem dynamics by forgoing protective conservation protocols and allowing their artworks to register natural reactivity to changing environmental conditions.

Renewable/Nonrenewable Materials

Pots of gold that remain full no matter how many coins are removed exist only in fairy tales. Gold is not considered a renewable resource, because it takes so long for the temperature of the volcanic magma to cool and form its minuscule particles. Thus, every ounce of gold that is mined today becomes unavailable for extraction by future generations. Resources like petroleum, coal, and iron ore are nonrenewable because they too take millions of years to form and replenish supplies that have been mined.

Topping the list of renewable resources are solar energy, wind energy, and geothermal power from the earth and the ocean, because they exist in infinite supplies. Other resources such as wood, oxygen, leather, and fish can be regenerated through natural processes. However, these naturally regenerating resources are only renewable if two conditions are satisfied: One, their use over time must equal the rate at which they can be replenished; that is, the rate at which trees are harvested must equal the number of trees that mature over the same time. Two, regenerating these resources must be cost-effective; that is, the monetary and environmental expense of raising and slaughtering cattle must be calculated into the production of meat and leather.

Affordability to current populations explains why the primary sources of energy that power contemporary lifestyles are nonrenewable. Sustainability for future populations explains objections to their use. Three terms have recently entered the discourse to mitigate both economic and environmental concerns:

1. *Carbon credits* manage the emissions of greenhouse gases associated with excessive burning of fossil fuels by trading among countries and organizations.[4] These credits were instituted to postpone peak oil.
2. *Peak oil* refers to the time when the world's crude oil production will reach its maximum output and then steadily decline until the wells run dry.

3. *Natural capital* shifts the concept of capital (a resource that is productive but is not consumed) away from machines, roads, and buildings. It assigns value to minerals, plants, and animals. The term highlights the essential services performed by resources that are not directly consumed by humans.

ACQUISITION

Material selection and use account for a significant component of art's total environmental impact, but not all. The means used to acquire these materials are also implicated in eco-materialistic strategies. Acquisition provides artists with another opportunity to manifest environmental responsibility. Strategies of acquiring materials that reduce dependence on processing, transportation, and packaging include the following:

- Purchasing raw materials and processing them into a useful medium
- Scavenging waste materials, most efficiently undertaken on site
- Collecting renewable resources on site
- Cultivating raw materials
- Processing or crafting your own medium

CONCLUSION

Even after materials that don't survive the scrutiny outlined in this chapter are discarded, the depot of eligible eco art materials still brims with opportunities to perform the marriage between enchantment and prudence. Each marriage of this sort propagates possibilities for *Homo sapiens* to live happily ever after on planet Earth.

NOTES

1 Bennett, Jane, "Thing-Power: Toward an Ecological Materialism," paper presented at the annual meeting of the American Political Science Association, Boston Marriott Copley Place, Sheraton Boston & Hynes Convention Center, Boston, Massachusetts, Aug 28, 2002. http://www.allacademic.com/meta/p65032_index.html.

2 Jane Bennett, *The Enchantment of Modern Life: Attachments, Crossings, and Ethics* (Princeton: Princeton University Press, 2001). http://culturemachine.tees.ac.uk/Reviews/rev27.htm.

3 Jane Bennett, "The Force of Things: Steps toward an Ecology of Matter," *Political Theory* vol. 32, no. 3 (June 2004), 347–372.

4 Quotas were established by the Kyoto Protocol, an international environmental treaty adopted in 1997.