takes a systems approach in which the interrelationships of soil, water, plants and wild and domestic animals are considered by the farmer. The new ethic involves respect for the lessons we can learn from nature: "Such a responsible agriculture can only be achieved when nature is both mentor and model, and when natural systems are the standard against which success is measured." By adopting nature as a standard, we rely on the success of processes that have evolved over billions of years and that can give us the knowledge we need to implement sustainable farming practices.

**Natural Resources at a Crossroads**

The Natural Resources principles are grounded in industries that have a direct and often damaging impact on the Earth. The principles highlight the changes necessary for developing sustainable practices in the extraction industries. These industries also have had a major impact on the economic development of nations. However, we are now at a crossroads and must shift from fossil fuels to renewable energy sources and from unsustainable to sustainable practices in logging, fishing and farming.

**Sustainability and Ecological Design**

"What is the good of having a nice house without a decent planet to put it on?"

—Henry David Thoreau

"Human subtlety will never devise an invention more beautiful, more simple or more direct than does Nature, because in her inventions, nothing is lacking and nothing is superfluous."

—Leonardo da Vinci

**Designing with Nature**

The Sustainability and Ecological Design principles examine the interdependence of human environments and ecosystems and point to the far-reaching effects that design decisions have on the environment. The statistics for the environmental impacts of buildings are staggering. In the United States, buildings are responsible for over 65 percent of total electricity consumption, 30 percent of total greenhouse gas emissions, 136 million tons per year of construction and demolition waste (approximately 2.8 pounds per person per day) and 12 percent of potable water use. Globally, buildings use 40 percent (3 billion tons annually) of all raw materials. Given the magnitude of the built environment, finding alternative building strategies that are in harmony with communities and ecosystems is imperative.
The benefits of sustainable or “green” building practices extend beyond reducing environmental impacts. Green building strategies also make wise business sense by promoting economic savings through reduced operating costs, by improving health and safety for occupants and visitors and by enhancing quality of life in local communities.

The principles of ecological design focus on the interaction of architecture, people and nature. They use environmental impacts (both positive and negative) to evaluate design and product life cycle and reinterpret the concept of waste. They explore the benefits of regenerative design, which goes beyond limiting environmental impact and strives to enhance our life-support systems. These principles also take a broad perspective that incorporates cultural, spiritual and historical traditions into the design process. Although the Sustainability and Ecological Design principles effectively integrate the environment (the First E of sustainability) into the design process, except in the Sanborn Principles economy/employment (Second E) and equity/equality (Third E) issues are not thoroughly investigated.

We will explore the general implications of the principles and then look at the significant points of each of the frameworks: William McDonough Architects’ Hannover Principles, Sim Van der Ryn and Stuart Cowan’s Five Principles of Ecological Design, John and Nancy Jack Todd’s Principles of Ecological Design, the Sanborn Principles and the LEED (Leadership in Energy and Environmental Design) Green Building Rating System®.

The Hannover Principles, written by architect William McDonough and chemist Michael Braungart, provide a holistic perspective on the tasks and responsibilities of architects; Sim Van der Ryn and Stuart Cowan’s Five Principles of Ecological Design illustrate simple ways of integrating nature into the design process; John and Nancy Jack Todd’s Principles of Ecological Design bring an innovative fusion of biology and engineering to their design solutions; the Sanborn Principles mesh natural and cultural resources with the built environment; and the LEED Green Building Rating System provides a powerful framework and standardized tool for implementing and measuring sustainability strategies in high-performance buildings.

The Hannover Principles

The framework for the Hannover Principles is based on the elements of Earth, Air, Fire, Water and Spirit. Sustainable design decisions are to be made within the context of these elements. One of the essential points of the Hannover Principles is that humans must coexist with nature. Implicit in this idea is our interdependence with the natural world, including the effects of design on the viability of ecosystems. The Hannover Principles consider “all aspects of human settlement,” going beyond physical structure to encompass the interactions of people with their built environment and with nature.

It is important to understand efficient energy use and the life cycles of products. Although embodied energy — the energy required to manufacture products — is not always considered, it can play a significant role in the environmental impact of a building project. The life-cycle concept speaks to the phases and costs (both economic and ecologic) of a product from its initial design to its use and eventual disposal.

The “cradle to cradle” approach to product life cycle requires that products be reintegrated into the manufacturing process or biodegrade. Rather than designing products with limited reusability (“cradle to grave”), designers use resources and design systems that support reuse in new products and services that support the manufacturing and ecological cycles. The cradle to cradle concept, explored by business management and industrial analysis consultant Walter Stahel from the Product-Life Institute in Geneva2 and by McDonough and Braungart in Cradle to Cradle: Remaking the Way We Make Things (2002), is redefining how we design products and systems to integrate them into a regenerative cycle.

The Hannover Principles were developed by William McDonough Architects for EXPO 2000, the World’s Fair for the
year 2000 in Hannover, Germany. The theme for EXPO 2000, “Humanity, Nature, and Technology,” incorporated the elements of ecological design. The principles were conceived “to inform the international design community of the issues inherent in the consideration of sustainable design, rather than to provide an ecological check list for construction.”

The Hannover Principles

1. **Insist on rights of humanity and nature to co-exist** in a healthy, supportive, diverse and sustainable condition.

2. **Recognize interdependence.** The elements of human design interact with and depend upon the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.

3. **Respect relationships between spirit and matter.** Consider all aspects of human settlement including community, dwelling, industry and trade in terms of existing and evolving connections between spiritual and material consciousness.

4. **Accept responsibility for the consequences of design decisions** upon human well-being, the viability of natural systems and their right to co-exist.

5. **Create safe objects of long-term value.** Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creation of products, processes or standards.

6. **Eliminate the concept of waste.** Evaluate and optimize the full life-cycle of products and processes to approach the state of natural systems, in which there is no waste.

7. **Rely on natural energy flows.** Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.

8. **Understand the limitations of design.** No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not as an inconvenience to be evaded or controlled.

9. **Seek constant improvement by the sharing of knowledge.** Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

The Hannover Principles should be seen as a living document committed to the transformation and growth in the understanding of our interdependence with nature, so that they may adapt as our knowledge of the world evolves.

The Hannover principles successfully address the interdependence of humanity and nature. This relationship manifests itself in accepting “responsibility for the consequences of design” — that is, recognizing our need to coexist with nature, eliminating waste and developing products and services aligned with this vision.

In *Cradle to Cradle*, McDonough and Braungart identify two metabolisms: biological and technical. The biological metabolism, or biosphere, refers to the cycles of nature and the technical metabolism, or technosphere, refers to the cycles of industry. For these metabolisms to remain healthy, valuable and successful, they should not mix or contaminate each other. As in nature, the concept of waste does not exist in these two cycles.

Products are divided into three categories: products of consumption, products of service or durables and unmarketables. Products of consumption are those made from materials that will biodegrade and become organic nutrients in the biosphere. Products of service or durables (such as cars, televisions, carpets, computers and
refrigerators) are licensed rather than sold. When such a product has outlived its use, it is returned to the manufacturer for reintegration into the manufacturing cycle as a "technical nutrient" or industrial "food" for the technosphere. Finally, the unmarketables are toxic and hazardous products, such as nuclear waste and polyvinyl chloride (PVC), which should be securely stored until we have developed the technology to detoxify or safely dispose of them.6

The Hannover Principles' "long-term value" emphasizes the challenge and responsibility to design structures, products and standards that broaden rather than restrict the possibilities for future generations. The limitations of design and of ourselves should lead us to "practice humility in the face of nature" and to learn about natural processes through observation and practice.

Although tailored for EXPO 2000, the Hannover Principles provide an innovative framework for sustainable design concepts with broad applications. The sense of humility and the sharing of knowledge illustrate the need for cooperation and partnership to seek lasting solutions to design problems. This realistic appraisal provides a refreshing look at the design industry. As William McDonough Architects state: "The Hannover EXPO is based on ideas of restraint, awareness, and concern for solving the world's problems, not hiding them behind a wall of promising machines."7

The Five Principles of Ecological Design

Sim Van der Ryn and Stuart Cowan's Five Principles of Ecological Design highlight the importance of understanding the local setting and designing structures that complement natural processes. One of their essential points deals with the sense of place. Knowledge and understanding of a proposed site plays a critical role in shaping the design process. When we become familiar with the nuances of a place, solutions reveal themselves.

These principles reiterate the importance of integrating design with nature to regenerate rather than deplete the ecosystem. Van der Ryn and Cowan challenge us to make "natural cycles and processes visible" by working with sunlight, water, temperature fluctuations and seasonal variations in our design structures. The more seamlessly these factors are integrated into the design, the less our activities will detract from the health of nature. Our awareness of the short- and long-term impacts of design on nature will help us determine ecologically sound design possibilities.

The Five Principles of Ecological Design stem from Sim Van der Ryn and Stuart Cowan's groundbreaking book Ecological Design (1995), which explores the integration of sustainability concepts and ecological design. The Five Principles clearly articulate the interdependence of design, function and nature. The principles are being implemented in the work of the Ecological Design Institute (EDI) and Sim Van der Ryn Architects.

### The five principles of ecological design

1. **Solutions Grow from Place.** Ecological design begins with the intimate knowledge of a particular place. Therefore, it is small scale and direct, responsive to both local conditions and local people. If we are sensitive to the nuances of place, we can inhabit without destroying.

2. **Ecological Accounting Informs Design.** Trace the environmental impacts of existing or proposed designs. Use this information to determine the most ecologically sound design possibility.

3. **Design with Nature.** By working with living processes, we respect the needs of all species while meeting our own. Engaging in processes that regenerate rather than deplete, we become more alive.

4. **Everyone is a Designer.** Listen to every voice in the design process. No one is participant only or designer only. Everyone is a participant-designer. Honor the special knowledge that each person brings. As people work together to heal their places, they also heal themselves.
5. Make Nature Visible. Denatured environments ignore our need and potential for learning. Making natural cycles and processes visible brings the designed environment back to life. Effective design helps inform us of our place within nature.

"Listen to every voice in the design process" emphasizes the value of cooperation from a variety of individuals with multidisciplinary perspectives. Linking nature’s well-being with our own, the principles point out: “As people work together to heal their places, they also heal themselves.” The focus on oneself, one’s place and the natural processes brings together the key concepts in sustainable ecological design.

The Todds’ Principles of Ecological Design

The search for lasting design solutions from a biological perspective is exemplified in the work of John and Nancy Jack Todd. The Todds’ principles provide a biological framework that places nature at the center of the design process. As the “matrix for all design,” the natural world is designated as the reservoir for ecological designers. Nature is both the teacher and the inspiration for design. The Todds emphasize that design must follow “the laws of life” — in other words, design must be in alignment with nature’s fundamental laws and processes. The concept of “biological equity,” which is covered widely by the principles in the Sustainability and the Biosphere chapter, focuses on the impact of design decisions on other species. The built environment, which arises from design decisions, often has catastrophic impacts on the environment.

John and Nancy Jack Todd’s Principles of Ecological Design stem from their book From Eco-cities to Living Machines (1994). The Todds co-founded the New Alchemy Institute and later Ocean Arks International and Living Technologies. Their work in ecological design incorporates aspects of energy, architecture, food production and waste management. Their living machines use microorganisms and plants to purify and reclaim water.

Principles of ecological design

1. The living world is the matrix for all design.
2. Design should follow, not oppose, the laws of life.
3. Biological equity must determine design.
4. Design must reflect bioregionality.
5. Projects should be based on renewable energy sources.
6. Design should be sustainable through the integration of living systems.
7. Design should be coevolutionary with the natural world.
8. Building and design should help heal the planet.
9. Design should follow a sacred ecology.

In stating that design must “reflect bioregionality” and be “coevolutionary with the natural world,” the Todds touch on the significance of the local ecosystem in the design process. The bioregion in many respects determines the local characteristics that, if carefully studied and observed, will point to an efficient design. The coevolution of design and nature illustrates the importance of creating a synergistic alliance between the designed environment and nature. In order to accommodate unforeseen changes, as nature evolves so must the built environment.

The Todds’ principles have similarities to the Hannover Principles and the Five Principles of Ecological Design. As do Hannover’s “recognize interdependence” and Van der Ryn and Cowan’s “design with nature” principles, the Todds repeatedly emphasize how nature provides the underlying structure as the “matrix” and the “laws of life” for the design process. The connections between design and the natural world provide the biological basis of the Todds’ Principles of Ecological Design. With a biological lexicon that includes the concepts of bioregions and coevolution, designers can strive to devise solutions that enhance rather than detract from the biological diversity of the natural world.
The Sanborn Principles

The Sanborn Principles apply the design values discussed by the Todds and by Van der Ryn and Cowan to the practical needs of a community. The Sanborn Principles successfully integrate social and ecological needs. Like Van der Ryn and Cowan's "design with nature" principle and the Todds' assertion that design must follow the "laws of life," the Sanborn Principles make a case for a close examination of the site and natural processes in devising design solutions. The Hannover Principles' reference to respecting the "relationships between spirit and matter" is reiterated by the Sanborn Principles' support for culturally creative and aesthetically pleasing structures.

The Sanborn Principles were developed at the Sanborn Conference, held near Colorado Springs, Colorado, in 1994. Numerous experts such as Amory Lovins, Paul MacCready and others in energy efficiency, renewable energy, single- and multi-family housing, anthropology, sociology, water conservation and transportation gathered there to envision crosscultural guidelines for a sustainable future. The principles provide a comprehensive approach to ecological design that considers building structure, its impact on the environment and the social, economic and esthetic implications. The principles since have been disseminated to many countries, including Canada, South Africa, Italy and Israel.

The Sanborn principles

1. **Ecologically Responsive**: The Design of human habitat shall recognize that all resources are limited, and will respond to the patterns of natural ecology. Land plans and building designs will include only those with the least disruptive impact upon the natural ecology of the earth. Density must be most intense near neighborhood centers where facilities are most accessible.

2. **Healthy, Sensible Buildings**: The design of human habitat must create a living environment that will be healthy for all its occupants. Buildings should be of appropriate human scale in a non-sterile, aesthetically pleasing environment. Building design must respond to toxicity of materials, care with EMF, lighting efficiency and quality, comfort requirements and resource efficiency. Buildings should be organic, integrate art, natural materials, sunlight, green plants, energy efficiency, low noise levels and water. They should not cost more than current conventional buildings. Features of the buildings and their surroundings should include:
   a. No waste that cannot be assimilated.
   b. Thermal responsiveness.
   c. Reflective or actively productive roofing or parking cover surfaces.
   d. Jungified or planted with native vegetation, both exterior and interior.
   e. Access by foot to primary services.
   f. Natural corridors near residences for wildlife.
   g. Individual and/or community gardens.
   h. Local agriculture for local consumption.

3. **Socially Just**: Habitats shall be equally accessible across economic classes.

4. **Culturally Creative**: Habitats will allow ethnic groups to maintain individual cultural identities and neighborhoods while integrating into the larger community. All population groups shall have access to art, theater and music.

5. **Beautiful**: Beauty in a habitat environment is necessary for the soul development of human beings. It is yeast for the ferment of individual creativity. Intimacy with the beauty and numinous mystery of nature must be available to enliven our sense of the sacred.
6. Physically and Economically Accessible: All sites within the habitat shall be accessible and rich in resources to those living within walkable (or wheelchair-able) distance. Accessible characteristics shall include:
   a. Radical traffic calming.
   b. Clean, accessible, economical mass transit.
   c. Bicycle paths.
   d. Small neighborhood service businesses; i.e. bakeries, tailors, groceries, fish and meat markets, delis, coffee bars, etc.
   e. Places to go where chances of accidental meetings are high; i.e. neighborhood parks, playgrounds, cafes, sports centers, community centers, etc.

7. Evolutionary: Habitats’ design shall include continuous re-evaluation of premises and values, shall be demographically responsive and flexible to change over time to support future user needs. Initial design should reflect our society’s heterogeneity and have a feedback system. They shall be:
   a. Villagified
   b. Multigenerational
   c. Non-exclusionary

One of the key features of the Sanborn Principles is the concept of health for building occupants and the environment. A building should be “healthy for all its occupants ... of appropriate human scale ... and aesthetically pleasing ....” In addition, building design must be responsive to toxic materials, electromagnetic fields (EMF), lighting, comfort and resource efficiency.

These parameters focus on the relationship between people’s needs and activities and a building’s capacity for accommodating them. Although comfort and esthetics are difficult to quantify, building occupants know when a building is a comfortable and pleasant place to live and work.

To preserve the health of the ecosystem, the Sanborn Principles focus on having minimal impact on the “patterns of natural ecology.” This concept, similar to those of permaculture (discussed in Sustainability and the Biosphere), advocates observing and learning from nature.

The Sanborn Principles also touch on social equity in building construction. “Habitats shall be equally accessible across economic classes” implies a commitment to providing affordable housing for everyone. The principles also promote accessible mass transit, traffic calming and the creation of places that bring people from the neighborhood together. In addition, the principles aim to maintain the character and cultural identity of ethnic groups within a neighborhood by creating environments that support human interactions.

The notion of beauty, mentioned by these principles, is difficult to define, yet speaks to the quality of life for individual community members, an important aspect of sustainability. The beauty of buildings is enhanced when they are well integrated with the landscape and when their function is seamlessly meshed with their esthetic value.

In calling for a “continuous re-evaluation of premises and values,” the Sanborn Principles emphasize the evolution of buildings. By advocating flexibility in building design, the principles support building techniques and structures that can easily be modified as new needs arise. Buildings become thriving structures able to change over time.

**US and World Green Building Councils: The LEEDing Edge**

One of the most encouraging developments within the Sustainability Revolution is the rise of the US Green Building Council with its international counterpart, the World Green Building Council, and the LEED (Leadership in Energy and Environmental Design) Green Building Rating System.¹²

Established in 1993, the US Green Building Council aims to “promote buildings that are environmentally responsible, profitable and healthy places to live and work.” Through the LEED products
and resources, GreenBuild, the Annual International Green Building Conference and Expo, and the current 157 LEED-Certified projects and over 1,700 LEED-Registered projects in all 50 states and 13 countries, the US and World Green Building Councils are spearheading a transformation in the building industry. In California, for example, in December 2004 Governor Arnold Schwarzenegger signed a landmark Green Buildings Executive Order setting a goal for state buildings to be 20 percent more energy efficient by 2015 and mandating “designing, constructing and operating all new and renovated state-owned facilities paid for with state funds as ‘LEED Silver’ or higher certified buildings.”

LEED is a rating system for designing, constructing and operating buildings. The system provides a useful standard to define the “green” aspects of buildings by evaluating areas such as: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Innovation and Design Process. These categories are assigned points that challenge owners and builders to strive for Certified, Silver, Gold and Platinum certification levels.

With a diverse membership of over 5,000 organizations including manufacturers, architects, builders, nonprofits, utilities, schools and state, local and federal governments, the US Green Building Council has a powerful voice that is reverberating in the international arena. Already Brazil, Canada, China, Guatemala, India, Italy, Japan, Mexico and Netherlands Antilles have LEED-Registered projects, demonstrating that the standard can adapt to different cultures and bioregions.

Though not perfect, LEED provides a powerful tool for industry professionals and owners to use in implementing sustainable strategies in their building projects. The LEED process involves third-party assessments and evaluation by technical and scientific committees to ensure unbiased conclusions and avoid “green washing” (giving the false impression of being “green”). LEED products are balloted by US Green Building Council members and subsequently implemented in the marketplace.

Designed to continually evolve as knowledge in the industry increases, the LEED system challenges its adopters to use a longer time-horizon when evaluating the costs and benefits of “green” projects. As the LEED programs continue to expand to include commercial interiors, core and shell construction, existing buildings, neighborhood developments and the residential sector, their impact undoubtedly will continue to shape the building industry and educate the public about the significance of building “green.”

An Interdependent Perspective

The principles of Sustainability and Ecological Design — Hannover Principles, The Five Principles of Ecological Design, Todds’ Principles, Sanborn Principles and LEED — recognize the interdependence of design and nature. The theme of nature as teacher and model, discussed later in Sustainability and the Biosphere, also is touched upon here. Buildings are integrated into their space and ideally mesh with the patterns and cycles of the natural world without detracting from or overpowering their setting.

McDonough and Braungart challenge us to reexamine eco-efficiency and instead consider eco-effectiveness in ecological design. Whereas eco-efficiency emphasizes reductions in resource consumption, energy use, emissions and waste, eco-effectiveness promotes optimal design strategies that support both human and ecological systems:

Our concept of eco-effectiveness means working on the right things — on the right products and services and systems — instead of making the wrong things less bad. . . . The key is not to make human industries and systems smaller, as efficiency advocates propound, but to design them to get bigger and better in a way that replenishes, restores and nourishes the rest of the world.

As McDonough and Braungart point out, the regenerative design approach may one day lead to buildings that, like trees, pro-
duce more energy than they consume and purify their waste water; factories whose “waste” is drinking water; products that when they are no longer needed can be composted in our backyards and serve as nutrients for plants and animals or be returned to the industrial cycle — in essence, a world of abundance rather than limits, pollution and waste.17

The Sustainability and Ecological Design principles also include cultural and spiritual values. Ecological design thus provides a thread that joins our cultural heritage with our present and future interaction with the environment and opens prospects for regeneration.

Sustainability and the Biosphere

Look deep into nature, and then you will understand everything better.

—Albert Einstein

Nature does nothing uselessly.

—Aristotle

Our Role in the Biosphere

The relationship between humans and nature lies at the center of sustainability. Since our impact on the natural world is powerful, widespread and often detrimental, new perspectives are arising regarding our place in nature. What is the role of nature as a model and teacher? How can we live in harmony with the natural world and create a vibrant and healthy economy that supports all life on the planet?

The Sustainability and the Biosphere principles address these and other questions that underlie the emerging environmental ethic. As with the ecological design principles, the biosphere principles focus mainly on ecological concerns (the First E) and only superficially address economic and equity (Second and Third E) issues. While each of the selected groups in Sustainability and the Biosphere provides guidelines for our interactions with nature, the critical links between employment and equity issues and ecological issues remain
vague and inconclusive. This uneven treatment of sustainability makes it particularly challenging to ground these principles in everyday life.

The concept of nature as a valuable teacher that can guide human actions permeates this section. Many of the principles point to the quite recent (geologically speaking) appearance of humans on Earth and the 3.8 billion years of existence and experience of other life forms. The principles emphasize that we are but one strand in a complex web of life and have much to learn from other species. Moreover, since humans and all other species depend on the ecosystems in the biosphere for survival we must be especially aware of human impact and responsibility.

In our analysis of Sustainability and the Biosphere, we will explore the general implications of each set of principles and then look at the significant points of each of the specific groups: Deep Ecology’s Basic Principles, the Charter of Rights and Responsibilities for the Environment, the Biomimicry Principles and the Mollison Permaculture Principles.

Deep Ecology’s Basic Principles are philosophical and action-oriented; the Charter of Rights and Responsibilities for the Environment is policy-based; the Biomimicry Principles look at nature as a beneficial model for business and industry; and the Mollison Permaculture Principles take a systems approach to our relationship with the natural world.

**Deep Ecology’s Basic Principles**

One of the most powerful themes in the deep ecology principles is the intrinsic value of non-human life. Appreciation for non-human species counters the Western development model, which seeks to exploit nature to accommodate human needs. For deep ecologists, the right of other species to exist is independent of human activities.

The deep ecology principles stem from the work of Norwegian philosopher and ecologist Arne Naess. The cornerstones of his deep ecology perspective include self-realization and biocentric equality. Self-realization is the concept of being connected to other life forces. Biocentric equality means that all species have the intrinsic right to exist. Thus, deep ecology asks us to reexamine our role in the web of life. The following principles of deep ecology were developed by Arne Naess and George Sessions:

<table>
<thead>
<tr>
<th>Deep ecology’s basic principles</th>
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<tbody>
<tr>
<td>1. The well-being and flourishing of human and nonhuman life on Earth have a value in themselves (synonyms: intrinsic value, inherent value). These values are independent of the usefulness of the nonhuman world for human purposes.</td>
</tr>
<tr>
<td>2. Richness and diversity of life forms contribute to the realization of these values and are also values in themselves.</td>
</tr>
<tr>
<td>3. Humans have no right to reduce this richness and diversity except to satisfy vital needs.</td>
</tr>
<tr>
<td>4. The flourishing of human life and cultures is compatible with a substantial decrease of the human population. The flourishing of nonhuman life requires such a decrease.</td>
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<tr>
<td>5. Present human interference with the nonhuman world is excessive, and the situation is rapidly worsening.</td>
</tr>
<tr>
<td>6. Policies must therefore be changed. These policies affect the basic economic, technological, and ideological structures. The resulting state of affairs will be deeply different from the present.</td>
</tr>
<tr>
<td>7. The ideological change is mainly that of appreciating life quality (dwelling in situations of inherent value) rather than adhering to an increasingly higher standard of living. There will be a profound awareness of the difference between big and great.</td>
</tr>
</tbody>
</table>
8. Those who subscribe to the foregoing points have an obligation directly or indirectly to try to implement the necessary changes.

Naess and Sessions point to the diversity of life as an essential component of the deep ecology framework. They believe that humans should "reduce" this diversity only to "satisfy vital needs." While what constitutes a vital need is not addressed by the authors, this ambiguity leaves room for the evolution of an ethic revolving around the question of "how much is enough?"

The deep ecology philosophy also stresses the significance of "life quality," defined as "dwelling in situations of inherent value," rather than "an increasingly higher standard of living." Again, as with "vital need," "inherent value" is undefined. It involves a subtle yet profound distinction between the richness of values that support life and the desire for increased consumption — better, not bigger, or "the difference between big and great." The deep ecology principles also point out the importance of reducing human population to permit non-human life to flourish, and put forth a call for action to those who support the principles.

Charter of Rights and Responsibilities for the Environment

Deep ecology's concern for all species is extended by the principles from the Charter of Rights and Responsibilities for the Environment. The charter highlights our interdependence with the natural world. Nature is defined a community to which humans belong rather than a "commodity" for our exploitation. We have a stewardship role in protecting the essential aspects of ecosystems such as air, water and soil.

The Charter of Rights and Responsibilities for the Environment stems from the Women and Sustainable Development: Canadian Perspectives Conference held in Vancouver, Canada, in 1994. The principles were developed by Ann Dale, then at the Sustainable

Development Research Institute, who declared that "if decisions are not made and acted upon now about how to live more sustainably ... a threshold of irreversibility will be reached, and options for future generations foreclosed." She proposed a legal approach based on the charter's principles that would be a powerful agent for change.

Charter of rights and responsibilities for the environment

- The biosphere is a community to which we belong rather than a commodity belonging to us.
- All species have inherent value in the biosphere.
- Human beings have stewardship for the quality of water, air and soil of the biosphere.
- The entropic throughput of natural resources should reflect their real costs as a factor in production and consumption.
- The health and well-being of humans and all other species is inseparable from the health and well-being of the biosphere.
- Development must be in harmony with the environment.
- Any production that is not sustainable cannot be counted as capital.
- Optimal allocation of human and natural resources must be in harmony with optimal scale, recognizing the finite limits of the biosphere.
- Human activity must not be conducted at the irreversible expense of other species and ecosystems.
- Diversity is integral to a sustainable society.
- Sustainable development maintains or enhances the integrity of natural resource capital, thereby contributing to the increased well-being of all species.
The present generation has an obligation to future generations.

The health of one nation ultimately affects the health of all nations.

The charter emphasizes the importance of taking into account the "real costs" of production and consumption. For example, the real cost of gasoline production, which is not reflected in the price at the gas station, includes the environmental destruction caused by extracting the petroleum; the military expenditures for securing oil fields, pipelines and shipping; the pollution and toxins released during refining; and the release of carbon dioxide from automobiles, which affects acid rain and global warming. The ripple effect of real costs is particularly relevant to sustainability issues confronting communities and commercial interests.

The charter also emphasizes the importance of observing the limits of the biosphere. These limits require optimizing human activities by aligning our actions with the needs and rights of other species. The sense of responsibility for ecosystems extends to an obligation of the present generation to future generations. This long-term perspective underscores a deep commitment to core values that support a responsible outlook to the future.

**Biomimicry Principles**

In her book, *Biomimicry* (1997), Janine Benyus describes how nature serves as a viable model, as a measure and as a mentor worthy of imitation by humans. "Biomimicry" comes from the Greek *bios* (life) and *mimesis* (imitation). As a model, nature provides insights in our quest for design solutions. For example, navigation in bats is the basis for radar technology, and architectural designs are derived from the structure of lily pads and bamboo shoots. As a measure or ecological standard, nature with its 3.8 billion years of evolution acts as a guide for humans. As a mentor, nature teaches humans to treat ecosystems not as a commodity but as a source of knowledge and inspiration.

The Biomimicry Principles focus exclusively on nature's attributes, implying that humans have much to learn from the natural world's evolutionary experience. Benyus portrays the significance of natural optimization of resources by stating that nature "uses only the energy it needs," "recycles everything," and "curbs excesses from within." Nature's optimization stands in sharp contrast to the inefficient use of nonrenewable energy sources, the tremendous waste in manufacturing and disposal habits and the excessive consumption in the industrialized nations.

**Biomimicry principles**

- Nature runs on sunlight.
- Nature uses only the energy it needs.
- Nature fits form to function.
- Nature recycles everything.
- Nature rewards cooperation.
- Nature banks on diversity.
- Nature demands local expertise.
- Nature curbs excesses from within.
- Nature taps the power of limits.

From an ecosystem perspective, the Biomimicry Principles point to the significance of cooperation and diversity, the antithesis of the competitive nature of our economic system and our reliance on monocultures. Benyus makes the interesting observation that nature "taps the power of limits." This principle recognizes how species maximize the benefits of the constraints of ecosystems in, for example, temperature range, seasonal variations and soil fertility. Within these boundaries, nature flourishes. In contrast, she states that "humans regard limits as a universal dare, something to be overcome so we can continue our expansion." The numerous examples of biomimicry projects in agriculture, health, materials and energy production and computers indicate the potential of her inspiring principles.
Permaculture Principles

David Holmgren and Bill Mollison co-created the concepts of permaculture in the 1970s. Mollison defines permaculture (derived from "permanent agriculture" and "permanent culture") as:

the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability, and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter, and other material and non-material needs in a sustainable way. Without permanent agriculture there is no possibility of a stable social order.6

Permaculture provides a systems approach for implementing architectural, energy, agricultural and community designs, among others. Like biomimicry, which recognizes the value of learning from nature, permaculture articulates a comprehensive design strategy based on knowledge gained through observing the patterns in nature. Patterning involves grasping the significance of these patterns by looking at characteristics such as shapes, branching, pulsing, waves, matrices, form and substance. The patterns furnish a template for designing systems that are interdependent and support each other in beneficial ways.7

Permaculture expands the scope of biomimicry by exploring ways of integrating sustainability concepts into economic and social endeavors from implementing alternative political systems, including bioregional organization, to new property arrangements, finance systems such as the Permaculture Credit Union8 and right livelihood.

Mollisonian permaculture principles9

1. Work with nature, rather than against the natural elements, forces, pressures, processes, agencies, and evolutions, so that we assist rather than impede natural developments.

2. The problem is the solution; everything works both ways. It is only how we see things that makes them advantageous or not (if the wind blows cold, let us use both its strength and its coolness to advantage). A corollary of this principle is that everything is a positive resource; it is just up to us to work out how we may use it as such.

3. Make the least change for the greatest possible effect.

4. The yield of a system is theoretically unlimited. The only limit on the number of uses of a resource possible within a system is in the limit of the information and the imagination of the designer.

5. Everything gardens, or has an effect on its environment.

The Mollisonian Permaculture Principles stress the importance of efficiency by advising us to work with nature, find the positive resource in an apparently negative situation and make "the least change for the greatest possible effect." Efficiency is rooted in allowing nature to lead in our design solutions.

The principles emphasize the critical role of information and imagination. While information undoubtedly is essential for decision making, the wise interpretation of information (not mentioned) is paramount in achieving lasting solutions. Imagination brings forth creativity in searching for ways to work with nature. Permaculture's systems approach is a powerful tool for creating a comprehensive perspective. Its focus on the relationships among species, natural forces and human habitation reveals the subtle nuances that characterize viable life-support systems.

Another set of principles that takes into account human interaction with the biosphere is the National Park Service's Guiding Principles of Sustainable Design. These principles establish a framework for designing and implementing sustainable practices through interpretative programs, natural and cultural resources and park facilities maintenance and operations. The National Ski Areas Associa-
tion's Environmental Charter, Sustainable Slopes, explores the environmental impact of the ski industry and presents guidelines that include ways of reducing energy and water consumption and protecting habitats.  

A Biocentric Perspective

The four groups of principles in Sustainability and the Biosphere — Deep Ecology, the Charter of Rights and Responsibilities for the Environment, Biomimicry and Permaculture — present a biocentric approach to sustainability. Nature is at the center and humans depend on it for knowledge, inspiration and survival. Recurring themes in the Sustainability and the Biosphere principles include the value of non-human species, interdependence and cooperation and planning for the well-being of future generations. Many of these principles stress the need for practical approaches to respecting and working within nature’s limits.

The biocentric viewpoint focuses on the importance of nature in maintaining Earth’s basic life-support systems. However, it pays less attention to the economic and equity (Second and Third E) aspects of sustainability. The inevitable interdependence of ecological issues with economic and equity issues provides a critical perspective for understanding the complexity of sustainability.

Future Pathways

I’ve grown impatient with the kind of debate we used to have about whether the optimists or the pessimists are right. Neither are right. There is too much bad news to justify complacency. There is too much good news to justify despair.

—Donella Meadows

The best way to predict the future is to invent it.

—Alan Kay

Principles: Scopes, Sectors and Types

The sustainability principles we have investigated in Community, Commerce, Natural Resources, Ecological Design and the Biosphere vary in scope, social sector and type. The principles range in scope from local to regional, national and international. They originate from government, business and industry, civil society or a coalition of stakeholders. While some principles focus strictly on values, others include a defined methodology or standard for implementation and evaluation. (See Figure 1 for details.) We also have examined environmental management tools such as ISO 14000, the Global Reporting Initiative (GRI) and the Ecological Footprint, which stand alone and provide useful metrics for implementing the sustainability principles.