
**From Biophilia to Cosmophilia:
The Role of Biological and Physical Sciences
in Promoting Sustainability***

Lucas F. Johnston

Wake Forest University, 118 Wingate Hall,
PO Box 7212 Reynolda Station,
Winston-Salem, NC 27109, USA
johnstlf@wfu.edu

Abstract

Ideas from the life sciences and the physical sciences, particularly the ideas that ecosystems, the planet itself, and even the cosmos are interconnected and 'organismic', have influenced the development of sustainability discourse. Sustainability advocates strategically deploy such scientific concepts through subtly spiritualized language and metaphors to advance their arguments. Even when the language of sustainability advocacy is not explicitly religious, it reflects core values and deep beliefs of particular individuals, communities, or groups. In such cases, sustainability movements derive their power by following a neo-religious narrative, and when deployed in the public sphere, such narratives are performing religious work.

Introduction

The scientists who conceived and constructed the first atomic bombs did not know, until they witnessed it, what shape the explosion would take. The detonation of an atom of u-237 manifested in a simulacrum of a life form: a tall, straight mushroom. Mushrooms typically grow out of dead and decaying matter, given life through the death of another (or tens of thousands of others). Like the mushroom-shaped cloud, an elegant irony accompanied the splitting of the atom: the perception and feeling of

* I am grateful to Bron Taylor, who helped me to focus the argument here, and two anonymous reviewers for their invaluable suggestions. I am also grateful for Connie Barlow's gracious help. Whatever shortcomings persist, of course, are my own.

deep interconnectedness with nature, which many bomb scientists reported, while laboring on one of the most destructive projects ever designed.

Physicists and life scientists have contributed to sustainability movements a sense of awe and reverence experienced through their professional work.¹ Such perception is typically grounded in an understanding of biological or cosmological relationality. While biophilic affinities extend to the carbon-based world, some scientists imagine human well-being against the backdrop of a larger cosmological narrative, and advocate for 'cosmophilic' affinities.² Both sorts of scientifically mediated feelings of interconnectedness with nature have been used to market sustainability-oriented narratives. Ideas drawn from sustainability and sustainable development have been deployed by industrial and governmental leaders, and also by countercultural groups for different ends. Through an analysis of certain ideas from the life and physical sciences that have influenced the idea of sustainability, namely the idea that ecosystems, the planet itself, or even the cosmos is a deeply interconnected and 'organismic' entity, it is clear that sustainability advocates often deploy scientific concepts, language, and metaphors strategically to advance their arguments, and to 'market' them to others. In such cases, scientific narratives are performing religious work, according to the definition offered by religion scholar David Chidester, by 'negotiating what it means to be human' (Chidester 2005: 18), and shaping the public sphere by 'forming community, focusing desire, and facilitating exchange' (2005: 5).

Although science is generally conceived (at least in the industrialized West) as the central pillar around which secular society structures its moral imagination, the cosmologies and implicit ethical imperatives presented in sustainability-related sciences at least run parallel to, and in

1. Sustainability movements are diverse and include light and dark green environmentalist subcultures, which have been analyzed by several scholars (i.e., Gottlieb 2006; Taylor 2010). Contemporary sustainability discourse, however, also includes those who frame their sustainability activism in purely human-centered terms (economic or social terms, for example) with little or no consideration of nature having 'its own good', or of any human obligations to non-humans. The sustainability milieu, generally speaking, retains a *human-centered* ethos that focuses on empathetic negotiation and personal and interpersonal responsibility.

2. Biophilic affinity often manifests in a 'kinship ethic', or an affectively oriented 'fellow-feeling'. There are many ways to characterize such interdependence and emotional attachment to other life. Cosmophilic narratives often express reverence for the dynamic *processes* and *relationships* that comprise the physical, chemical, and biological systems rather than expressing affinity for individual organisms.

many cases 'intertwingle' with more explicitly religious interpretations of such phenomena.³ Holistic scientific approaches, including systems theory, adaptive management, and the 'new physics' emerged in the twentieth century and proved to be particularly fertile partners for naturalistic and organismic spiritual expressions. For instance, Ervin Laszlo, often mentioned as a founder of systems theory, later founded the Club of Budapest, the successor to the Club of Rome, to promote 'global consciousness'. Their mission statement claims to integrate spirituality and science: 'Like Greenpeace fights for ecological issues, UNICEF for children, and Amnesty International for human rights, the Club of Budapest stands for global consciousness. Its mission is to be a catalyst for the transformation to a sustainable world'.⁴ One of the fathers of adaptive management, H.T. Odum, proposed a holistic energy-accounting theory that included formulae for calculating the energy output and return of religion in embodied systems (1971). Fritjof Capra, a physicist often referred to as a systems theorist, popularized the spiritual dimensions of the new physics, relating them to Eastern mystical traditions (1984 [1975]), and, since the turn of the millennium, to sustainability (2004).⁵ In various ways these holistic sciences represent the first steps toward what the biologist Edward O. Wilson termed 'consilience' (1998), the unity of knowledge through the scientific enterprise. This process can be clarified by examining how scientific ideas and data are gathered

3. The term 'intertwingle' comes from Paul Hawken, immersed for over thirty years in the sustainability milieu, who used it to describe the complex intellectual cross-fertilization of different groups within civil society whose means and goals are different (2007: 5). Perhaps most interestingly, these groups exchange ideas rather freely across political and cultural boundaries. Hawken invented this term, but work tracing the free exchange of ideas and metaphors across subcultures has a long history (see Campbell 1972).

4. See www.clubofbudapest.org (accessed 7 January 2009).

5. Systems theory began to emerge in the middle of the twentieth century. The publication of Austrian biologist Ludwig von Bertalanffy's *General System Theory: Foundations, Development, Applications* (1969) was an important milestone. The discipline of adaptive management grew from Odum's work at the University of Florida, and that of C.S. Holling, first in British Columbia and later at the University of Florida. One of Odum's doctoral students in Florida, Robert Costanza, has become one of the leading authorities on integrated global modeling for sustainable use and conservation of natural resources (see http://www.uvm.edu/giee/?Page=about/Robert_Costanza.html&SM=about/about_menu.html [accessed 7 January 2009]). Some scholars, such as Fikret Berkes (2008 [1999]) have suggested that adaptive management can be integrated with traditional ecological knowledge to create a 'sacred ecology'.

by scientists, displayed for the public eye, digested and politicized in the democratic arena, and then re-deployed in the context of sustainability.⁶

The Search for a 'Bridging Science'

Sustainability is deployed in diverse ways in the public sphere by different constituencies but they all use science (or pseudo-science) to buttress their formulations of sustainability. As rhetoric analysts Killingsworth and Palmer noted, 'the connection between science and the environmental reform movements—a match directly encouraged by authors like [cultural historian] Thomas Berry and implied in the perspective of deep ecology—has become the most problematical and the most important link in the evolution of environmental politics in America' (Killingsworth and Palmer 1991: 48).

At least within the Western scientific tradition, the first seeds for this blossoming relationship were planted around the turn of the twentieth century as several physicists (such as Ernest Rutherford and Max Planck) conducted experiments that opened the door to a new sort of physical science that would later become known as quantum mechanics. In 1935 Albert Einstein, Boris Podolsky, and Nathan Rosen published a three-page thought-experiment in *Physical Review* (now commonly referred to as the EPR paper) that was designed to test whether the quantum mechanical picture of reality could be considered complete.⁷ Their experiment helped to usher in two research programs that are relevant to the idea of sustainability. First, it set the stage for early work on atomic fission, and

6. Although most of the sustainability discourse derived from biological and physical sciences deals with the environmental or ecological dimensions of sustainability, it is widely agreed that sustainability includes social and economic imperatives as well as environmental ones. While much of what I discuss here does fall under the umbrella of environmental sustainability, these ideas also exert influence on the social and economic dimensions of sustainability by helping to focus communities and facilitate exchange relations in particular directions.

7. They discovered that two particles, having once interacted, continued to display instantaneous correlated behavior even when separated by such a distance that they could not be causally related according to relativity theory. For the experimental 'singlet' state, the statistical predictions of quantum mechanics were incompatible with separable predetermination. Either the particles were exchanging information faster than the speed of light, or the quantum mechanical explanation must be considered incomplete. EPR assumed the correctness of relativity, and that what Einstein called 'spooky action at a distance' was illogical, thus concluding that the quantum mechanical description of reality was *not* complete. As EPR put it, 'No reasonable definition of reality could be expected to permit this [correlation of two distant particles without direct causal relationship]' (Einstein, Podolsky, and Rosen 1983 [1935]: 141).

thus, the first atomic bombs. Second, the notion of ‘quantum entanglement’, the focus of their ruminations, blossomed into an interpretive metaphor that exhibited elective affinity for other holistic interpretive frames, such as systems science, the Gaia hypothesis, and later narratives such as Thomas Berry and Brian Swimme’s ‘Universe Story’ (Swimme and Berry 1992).⁸

The affinities for deep relationality among physicists have parallels in the life sciences. Certainly the roots of the notion of biophilia were present much earlier, including in the writings of Charles Darwin (Taylor 2010: 30-31), Gilbert White (Worster 1985 [1977]: 3-14), John Burroughs (Taylor 2010: 69-71; Worster 1985 [1977]: 14-23), and other life scientists, who experienced a sense of awe and wonder in nature during their lives and research. In addition, naturalists such as John Muir, Ralph Waldo Emerson and Henry David Thoreau had voiced such ideas before the turn of the twentieth century (see Taylor 2010: Chapter 3 for a detailed analysis). The primary contribution of Edward O. Wilson and other conservation biologists in the twentieth century was the generation of memorable terms such as *biodiversity* and *biophilia* for use in the fight for conservation and the discourse of sustainability (Takacs 1996; Wilson 1984).

Others, such as popular science writer Connie Barlow, connected this love of biological diversity to a larger narrative of cosmological unfolding. Borrowing a phrase from Julian Huxley, Barlow and her husband Reverend Michael Dowd popularized this cosmic-scale ‘epic of evolution’.⁹ Bron Taylor noted this emerging movement in the *Encyclopedia of Religion and Nature*,

a growing number of scientists...share a central, common denominator belief in...the sacrality of the evolutionary processes that produce biological diversity. Participants in such scientific professions often view their

8. Later experimenters concluded, contrary to EPR, that these two particles were ‘entangled’, internally related, a phenomenon that prompted later physicists such as David Bohm to describe the universe as an ‘undivided whole’ (1993) containing an ‘implicate order’ (2002 [1980]). Others, such as Fritjof Capra, likened the science of quantum physics to Eastern mystical religions (1984 [1975]).

9. See Dowd (2009), Barlow (1997), and their website at www.thegreatstory.com (accessed 2 January 2010), which has links to much of their material. Barlow informed me that she recalled interviewing E.O. Wilson and noting that he had used the term ‘evolutionary epic’ in his *On Human Nature* (1978). She noted to Wilson that Julian Huxley had first used the phrase, and told me Wilson was glad for this ‘convergent evolution’, to use Barlow’s phrase (private communication, 17 December 2009). This cosmological narrative, Barlow and Dowd note on the website, can also be referred to as ‘the great story’ or the ‘universe story’, the latter drawn from the title of a work by the physicist Brian Swimme and the cultural historian Thomas Berry (1992).

work as a spiritual practice. Some of these have been influenced by those who, like the religion scholar Thomas Berry, believe that science-grounded cosmological and evolutionary narratives should be understood as sacred narratives, and that so understood, they will promote reverence-for-life ethics (Taylor 2005: xvii-xviii).

Twentieth-century scientists such as Aldo Leopold (Meine 2005), Rachel Carson (Sideris and Moore 2007), E.O. Wilson (1998, 2006), Stephen Kellert (Kellert and Farnham 2002; Kellert and Wilson 1993) and James Lovelock (1979, 2007) have all contributed to the cache of religious metaphors available for advocacy. According to Lovelock's now well-known Gaia hypothesis, the earth could be imagined as a self-regulating super-organism. Much to his surprise, Gaia theory became standard fare among many New Age and Neopagan communities searching for new metaphors to guide their search for human meaning (Monaghan 2005), and a popular accompaniment to deep ecology; it is also an influential tributary to one form of 'dark green' religion, in Bron Taylor's work (Taylor 2010).

To investigate such uses of scientific discourse, Killingsworth and Palmer employed a model with a continuum of perspectives on how humans value nature: from 'Nature as Object' (one extreme) to 'Nature as Spirit' (the other extreme). Their most novel suggestion was that this linear continuum was bending into a horseshoe, the ends moving gradually toward one another, as contemporary science evolved in a direction that fostered the emergence of a *bridging science* capable of integrating these two former extremes (1991: 14). As traditional Western science (on the 'Nature as Object' end) gradually adopts the organismic worldview common in deep ecology (which lies at the opposite end of the continuum), the bridge is constructed.¹⁰ Their discussion of possibilities for such a bridging science included 'nascent theories that could close the gap and turn the horseshoe into a circle, such as the Gaia hypothesis... and holistic versions of general systems theory', but these were at the time 'still consigned to the margins of the accepted canon of knowledge' (1991: 16).

Over 15 years have passed since Killingsworth and Palmer's work, and the Gaia hypothesis remains controversial among scientists. Its premises, however, have been woven into mainstream venues, such as

10. Killingsworth and Palmer's analysis is provocative, but their analysis of environmentalist subcultures requires further nuance. They use the term 'deep ecology' in a very general context, to refer to a broad cross-section of social and political movements that consider nature as having intrinsic and usually spiritual value. They do not use it to refer to the more specific branch of environmental philosophy first proposed by Norwegian philosopher Arne Naess (1973).

the invocation of 'Mother Earth' tropes in international political venues under the United Nations umbrella (Hart 2005; Taylor 2004, 2010). The notion can also be seen in the personification of the environmental systems in many climate change discussions (Monaghan 2005; NWEI 2007). The ability of such ideas to slide between consensus and non-consensus science illustrates how the sustainability milieu functions as a marketplace for concepts and practices. The medium of exchange often takes the form of a spiritualized discourse that resonates with traditional science, yet posits a 'cosmic consciousness' that appeals to many in the sustainability milieu, from deep ecologists and their intellectual kin to international development organizations and political institutions.¹¹ While Killingsworth and Palmer hoped that the Gaia hypothesis or a holistic form of ecology might effectively bridge the horseshoe, the global sustainability movement is one place where systems science, the Gaia hypothesis, adaptive management theories and practices, and holistic language, hybridize and gain cultural strength through positive feedback loops. Through a historical lens, it is possible to see how the narrative of sustainability emerged to fulfill the need for this bridging science.

From Biodiversity to Biophilia

One of the specific terms used across disciplines and constituencies within contemporary sustainability discourse is 'biodiversity'. Like sustainability and religion, biodiversity is a malleable and emotively charged term deployed for particular purposes. Coined and developed by conservation biologists, the term expresses some of the normative flavor of that professional field. But its use has flourished beyond its early confines.

The Idea of Biodiversity

David Takacs's *The Idea of Biodiversity* (1996) traced the idea of biodiversity back to scientists such as Aldo Leopold, Charles Elton, and Rachel Carson. Before the term was coined, they employed similar concepts such as 'natural variety, flora and fauna, wildlife, fellow creatures, wilderness, or simply nature' (Takacs 1996: 11). Norman Myers (1979) and

11. Colin Campbell (1972) gave the name 'the cultic milieu' to the conceptual communication between oppositional subcultures. Bron Taylor later adapted Campbell's ideas to refer to the 'environmentalist' milieu (see, for example, Taylor 2010). The social movements I refer to here could, drawing on this practice, be referred to as existing as part of the sustainability milieu.

Paul and Anne Ehrlich (1981), who published books detailing the quickening of species loss, all believed that these disappearing species possessed intrinsic value, and the Ehrlichs suggested that their argument for preserving biological diversity was at bottom a religious one (Takacs 1996: 35). The first popular appearance of the shortened term 'biodiversity' probably came in 1986, at the National Forum on BioDiversity, sponsored by the National Academy of Sciences (NAS) and the Smithsonian Institution.¹² From the beginning, biodiversity was envisioned by the organizing biologists as a tactical term designed to influence governmental and public perception of the loss of species and habitats. Participant Dan Janzen stated that the forum was 'designed to make Congress aware of this complexity of species we're losing... The word [biodiversity] was coined...[and] punched into that system at that point deliberately' (Takacs 1996: 37). In short, conservation biologists' promotion of biodiversity was a way to market the idea of ecological limits (or carrying capacity) in a way that was explicitly normative. As Takacs put it:

Battles over biological resources rage...in every remote corner of the Earth. These battles...set at odds the perceived needs of humans and those of many millions of other species, and of the natural processes that nourish them and us. Scientists who love the natural world forged the term *biodiversity* as a weapon to be wielded in these battles (1996: 3).

For many, biodiversity is the defining feature of sustainability, and the economic and social dimensions are subsumed under the quest to maintain biodiversity (see Patten 2000).¹³ In many cases, ideas related to biodiversity are blended with themes of deep interdependence and a generic form of nature reverence. Tim O'Riordan, for example, used highly emotive, even religious language, in describing the importance of biodiversity: 'The future of biodiversity signifies the future of humankind... By being cognizant, and by being morally alive, humanity can save its own body and soul' (O'Riordan 2002: 13). As Takacs noted, this language is not so unusual. Later in the same work, O'Riordan returned to the theme of deep relationality: 'Not to protect biodiversity means not to protect humanity from its communion with the planet. As we lose biodiversity, so we lose our individual and collective souls. To use biodiversity as a barometer for our ethos, and as waymarks for our pathways towards sustainability, is our best course' (O'Riordan 2002: 26).

12. Given the normative character of the term biodiversity, Takacs noted that 'it is ironic...that the term *biodiversity* and the politics it has engendered sprang from this august and cloistered institution [the NAS]' (1996: 36).

13. Patten's book includes contributions from many well-known scientists, such as Thomas Lovejoy, Vandana Shiva, and political personalities such as Gro Brundtland and HRH Prince Philip.

The Love of Diversity

In the latter part of the twentieth century, as it became clearer to scientists that the resilience of ecosystems and the evolution of *Homo sapiens* historically depended on biologically rich habitats, some articulated feelings of awe and reverence stirred by the world's complexity. The spiritualized language used by scientists to describe the reasons individuals and governments ought to care for biological diversity indicated the further metamorphosis of the idea of biodiversity toward an affectively oriented affinity for living things. With the publication of *Biophilia* (1984), Edward O. Wilson sought to explain in genetic and biological terms why biodiversity might be related to human 'souls'. Wilson popularized *biophilia*, the idea that living organisms possess a genetically based affinity for other living things, which he believed should evoke a deep awe and concomitant respect for nature and a new foundation for ethics based on the adaptive advantages of ecosystem preservation (Wilson 1984).¹⁴ Citing Aldo Leopold's 'land ethic' as the foundation for an ethical relationship with nature, Wilson's collaborator Stephen Kellert stated plainly that 'biological diversity and the ecological processes that make it possible are the crucibles in which our species' physical, mental, and spiritual being have been forged' (1993: 26). Kellert went on to suggest that 'mitigation of this environmental crisis may necessitate nothing less than a fundamental shift in human consciousness' (1993: 26).

This shift in consciousness, what Leopold characterized as an 'ecological conscience' (1949: 207-10), was explained by the philanthropist and author Scott McVay in his prologue to Kellert and Wilson's *The Biophilia Hypothesis* (1993). Alluding to Melville's masterpiece *Moby Dick*, McVay recalled a scene where the protagonist Ishmael is tethered to one of his whaling mates while the partner removed the blubber from a kill. Ishmael pondered the implications of the rope between them, and realized that his mate's fate would be his own: 'this situation... was the precise situation of every mortal that breathes... he, one way or other, has this *Siamese connexion* [sic] with a plurality of other mortals' (McVay 1993: 5).

McVay related several instances of what might be called biophilic 'conversion' moments, where people were quite suddenly struck by the 'humanness' of other animals, prompting the recognition that the emotional lives of animals are every bit as rich as ours.¹⁵ One story recalled

14. Stephen Kellert defined biophilia as 'The idea that people possess a genetic inclination, grounded in the quest for individual and collective fitness, to attach physical, emotional, intellectual, and moral meaning to nature' (2005: 185; see also Kellert and Wilson 1993).

15. For a book-length treatment of the emotional lives of animals, see Bekoff's *The Emotional Lives of Animals* (2007).

an acquaintance of McVay's who remained skeptical about reports of porpoises rescuing drowning swimmers. One day, McVay offered to take her to the lab of an acquaintance which held a tidal pool and a female porpoise. The woman acquiesced, and once there entered the water and assumed 'the dead man's float'. McVay's retelling of the incident is worth quoting:

From behind, the porpoise swam onto the woman's back and clasped its flippers firmly under her arms and began to propel her around the pool with powerful tail flukes. At first she resisted. She was unused to letting go or losing control. She noticed, however, that she could see and breathe. The weight and vertical stroking of the flukes lifted her head clear of the water as the two—joined by a belly-to-back Siamese connexion—made a circuit of the pool to the gasps of the onlookers. She 'let go'. She told me she relaxed as deeply and as fully as she ever had. The porpoise made two complete circuits of the pool and then shot straight up in the air, releasing the woman gently and precisely on her knees on the cement lip of the pool. She said softly, 'I understand' (McVay 1993: 7).

By 'letting go' of her assumptions about other-than-human animals, she formed an emotively grounded connection with the dolphin. The swimmer's expression of 'understanding' did not indicate she understood how dolphins saved swimmers. She was conveying a deeper lesson taken from a profound and affectively rich encounter with another being. If the scientific concept of biodiversity recognizes the richness of life, biophilia suggests that humans form an affective bond with this interdependent web of life. The idea that we can, and should have affinity for other life is central to many sustainability movements.

The idea and putative importance of biological diversity made its way into the Brundtland report, the most well-known work elucidating the idea of sustainable development.¹⁶ The maintenance of 'biological diversity' and 'genetic' diversity are both referred to as crucial for achieving sustainable development for a variety of reasons, including potential contributions to human welfare, ecosystem services (World Commission on Environment and Development [WCED] 1987: 147-48), and 'ethical cultural, aesthetic, and purely scientific reasons for conserving wild beings' (WCED 1987: 13). The Commission concluded Chapter 6 on 'Species and Ecosystems' with the admonition that 'Our failure to [save species and their ecosystems] will not be forgiven by future generations' (WCED 1987: 166). It is worth noting that this phraseology closely paralleled E.O. Wilson's earlier claim in *Biophilia* that 'the one process now

16. This report, entitled *Our Common Future* (1987), was orchestrated by Gro Harlem Brundtland, the chair of the World Commission on Environment and Development.

going on that will take millions of years to correct is the loss of genetic and species diversity by the destruction of natural habitats. This is the folly our descendants are least likely to forgive us' (Wilson 1984, quoted in McVay 1993: 4).

These themes of interconnectedness and interpersonal relationship, couched in religion-resembling language and grounded in scientific evolutionary narratives, are common among life scientists engaged in sustainability discourse. Biophilia grants an additional layer of affective power to the already rich idea of biodiversity. For Wilson, Kellert, and others, the human affinity for other life is an adaptive evolutionary trait and the basis for environmental ethics. These ideas and metaphors, illustrative of a deep human affinity for the natural world, however, were also spliced onto broader cosmological narratives, facilitating the further emergence of an affectively rich spirituality grounded in 'cosmophilia'.

From Biophilia to Cosmophilia

Spurred by the metaphysical speculations of famous physicists such as Albert Einstein, David Bohm, Fritjof Capra, and Richard Feynman, by the middle of the twentieth century physicists were also articulating awe and reverence inspired by their work, and were thus contributing to the still nascent myth of sustainability. Killingsworth and Palmer argued that the completion of the atomic bomb was the crowning moment for the 'Nature as Object' end of their values continuum: 'Their [science, government, and industry's] greatest glory came in alliance with one another, potentially symbolized in the Manhattan Project and the continued development of the scientific-military-industrial complex after World War II' (1991: 15). But these successes were facilitated by men whose motives were not so much military as human.

Environmental historian Mark Fiege argued that the motives of the bomb scientists were deeply connected to their experiences in nature, which moved them to pursue science as a profession in the first place. Like the life scientists discussed above, the Manhattan Project scientists, Oppenheimer, Meitner, and Rabi, all had childhood experiences that 'mirrored events in Rachel Carson's girlhood' (Fiege 2007: 585). Fiege also compared Carson's upbringing with that of noted physicist and public intellectual Richard Feynman: 'Nature study with loving parents, wonder experienced in local landscapes, scientific careers, the championing of unmediated contact between children and the physical world: Carson and Feynman shared much' (2007: 587).

Fiege noted that many of these scientists' best ideas materialized or were vetted on long walks in natural settings. Oppenheimer had a ranch in the mountains of New Mexico, and many of the European scientists working on the project were mountaineers. While the bomb was being tested, Oppenheimer, speaking with another of the project scientists, supposedly gazed at the Sierra Oscura range in the background and muttered, 'Funny how the mountains always inspire our work' (Fiege 2007: 579). Fiege argued that 'Physicists, chemists, and mathematicians studied atoms out of profound curiosity, and when they detected the inner workings of the tiny particles, they experienced awe, amazement, delight, and transcendence' (2007: 581).

Of course, such awe and reverence did not prevent them from building a new type of bomb that caused mass death wherever it was unleashed. But Fiege, comparing Oppenheimer to Leopold this time, argued that when Oppenheimer realized the destructive capacity of the bomb, and understood that humanity's only hope

Lay in the binding obligations of the world community, [Oppenheimer] was closer to Leopold than either of them could have known. Oppenheimer and other atomic scientists could find inspiration in a mountain. But somewhere on a lonely, windswept, vertiginous slope, they also learned, in their own way, to think like one (2007: 602).¹⁷

This reference to Leopold's 'conversion' moment, often referred to as a paradigmatic example of an ecocentric ethic, suggested that Oppenheimer and others like him were beginning to perceive the outlines of a broader, more cosmocentric ethic.

Like the first views of the earth from space, the detonation of the first atomic bombs brought a deeper level of consciousness to the global community. It was abundantly clear for the first time in recorded history that *Homo faber* had manufactured a tool that could cause its own extinction. The sustainability of the planet's diverse species was for the first time questioned by large portions of the global population. Many sustainability advocates began their activist careers protesting the nuclear arms races of the Cold War period, illustrating important intellectual connections between the development of nuclear weapons and

17. This quote refers to a well-known chapter of Leopold's *Sand County Almanac* titled 'Thinking Like a Mountain' (1949: 129-33). There, Leopold discussed his belief that 'fewer wolves meant more deer, that no wolves would mean a hunter's paradise' (p. 130). On one occasion, however, Leopold shot a she-wolf and watched as a 'fierce green fire' died in her eyes. This mysterious fire represented 'something new' to Leopold, 'something known only to her and the mountain' (1949: 130). Leopold sensed that his opinion of wolves was not shared by the mountain.

concern with sustainability.¹⁸ Some early invocations of ideas related to global sustainability were vetted in international commissions such as the Palme Commission (1982), which was explicitly dedicated to addressing the threat of thermonuclear war (Wiseman 2005). Although cosmophilia does not depend upon empathetic engagement with specific organisms or ecosystems, as does biophilia, it does offer an organismic concept of universal unfurling that includes diverse earth-bound creatures.

In the instances discussed above (which only hint at the depth and richness of such discussions), spiritual ideas and ideals are used both to interpret scientific data, and to translate these interpretations to others. The two ideas that most commonly emerge from holistic interpretations of science are the foundational interconnectedness of the living world and the cosmos, and the notion that a 'consciousness' of human affinity for the unfolding universe, 'a cosmophilia', is emerging.

Science and the Narrative of Sustainability

Biodiversity, biophilia, and invocations of what I have here called cosmophilia imply the sacredness of evolutionary processes and have been influential within sustainability discourse. The ideas that humans have a deep and affectively oriented affinity for living things or the entire cosmos are increasingly discussed in contemporary scholarship, the popular realm, and the policy arena. Just as oppositional or environmental subcultures exchange ideas and metaphors rather freely, within the sustainability milieu ideas such as biophilia and cosmophilia may arise independently (within the life sciences and physical sciences, respectively), but these ideas are then exchanged across the boundaries of these disciplines with ease. Moreover, such ideas exert influence on other academic disciplines relevant to sustainability, such as environmental ethics.

In 1985, for example, the environmental philosopher J. Baird Callicott drew on quantum mechanics as a source for environmental ethics to solve what he called the 'most recalcitrant problem for environmental ethics', the creation of a coherent theory of the intrinsic value of

18. For example, energy physicist Amory Lovins's and L. Hunter Lovins's first co-publications were on the implications of energy policy for natural security in an age of nuclear weaponry (see A. Lovins and H.L. Lovins 1980; H.L. Lovins and A. Lovins 1982). Activist and Buddhist scholar Joanna Macy began conducting what she called 'Despair and Empowerment Workshops' to help people cope with and vent the emotional strain caused by the (mushroom) cloud of impending doom that loomed as the Cold War heightened (see Macy 1983). She later became a strong proponent of an eco-friendly form of Buddhism.

non-human nature (1985: 257). Drawing on the physicist Fritjof Capra and the human ecologist Paul Shepard (influential in the deep ecology and ecopsychology movements), Callicott argued that 'if quantum theory and ecology both imply in structurally similar ways in both the physical and organic domains of nature the continuity of self and nature, and if the self is intrinsically valuable, then nature is intrinsically valuable' (1985: 275).¹⁹ A similar idea was later popularized by the Australian deep ecology activist John Seed, who influentially asserted that when he was defending the rainforest, he was really the forest becoming conscious, defending itself.²⁰ Some sustainability oriented groups have embraced the sort of affinity for nature promoted by life scientists such as Aldo Leopold and Rachel Carson, physicists such as Capra and Brian Swimme, and have disseminated ideas such as Lovelock's Gaia hypothesis and Kellert and Wilson's biophilia hypothesis.²¹

The biological concept of biophilia and the science-based notion of 'cosmophilia' have been critically important tributaries to sustainability discourse, spirituality, and ethics. They have promoted community among sustainability activists, prioritized specific exchange relations (in the form of sustainable purchasing and fair trade movements), and provided environmental and social objectives for communities. Even when sustainability advocacy is not explicitly religious, it generally reflects the

19. Callicott asks the reader to assume 'a) with Shepard and Capra that nature is one and continuous with the self, and b) with the bulk of modern moral theory... that self-interested behavior has a *prima facie* claim to be at the same time rational behavior'. Following this logic to its conclusion, 'the central axiological problem of environmental ethics... may be directly and simply solved' (1985: 275).

20. In this essay, Callicott is not defending *objective* intrinsic value (as Holmes Rolston III often does [see Rolston III 1993 for an example related to biophilia]), but rather a *subjective* intrinsic value, where human valuers are required to encounter nature, and consider it to be valuable for its own sake. In essence, Callicott is really making two points: a) first, that quantum mechanics helps to overcome the fact-value dualism by positing emergent complementary properties; and b) that quantum theory offers a new 'cosmological-metaphysical' interpretive frame that transcends traditional rationality (here I draw on, and am in accord with, Michael E. Zimmerman 1995 [1988]).

21. For example, Einstein, Capra, Carson, Leopold, and many other ecological 'heroes' are honored with pages in the Better World Project's Earth Day coloring book. The Better World Project is dedicated to the 'diverse movements for change' toward a 'just and sustainable world'. For more information about Better World, see <http://www.betterworld.net> (accessed 18 June 2008). The NWEI, which provides materials for community-level discussion groups, has selections from each of these luminaries in their readers, which have reached well over 100,000 people in the United States and Canada (see www.nwei.org [accessed 16 December 2009]).

core values and deepest beliefs of the individuals, communities, and groups who deploy the term in the public sphere; in this it is performing religious work. To the extent that these scientists are treading on normative territory, and are connecting their own existence and moral sensibilities not only to living things, but also to evolutionary and cosmological narratives that are understood as sacred in some way, they are contributing to the religious myth of sustainability and effecting social change.

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