ECOLOGY AND ENVIRONMENTAL ETHICS

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Arthur Cooper, former president of the Ecological Society of America, correctly noted that a lot of environmental ethics and policy directly relies on ecological science (Cooper 1982, 348; Shrader-Frechette and McCoy 1993, 2; Hanssen, Rouwette and van Katwijk 2009). In fact, to illustrate this point, one need think only of cases such as banning DDT, limiting acid rain, managing coastal zones and forests, and protecting endangered species. In all these environmental policies, ecological science has played a pivotal role.

MISGUIDED APPEALS TO ECOLOGICAL LAWS AMONG ENVIRONMENTAL ETHICISTS

Environmental ethicists often make erroneous appeals to ecological science, however, when they attempt to justify their specific ethics and policy conclusions. For instance, Baird Callicott (1989, 22), Aldo Leopold (1949, 224–225) Holmes Rolston (1988), Stanley Salthe (2005), Paul Taylor (1986, 50), and others subscribe to variants of the balance-of-nature thesis. Rolston (1988, 231) claims “the paramount law in ecological theory” is “homeostasis,” and he ties environmental ethics to maintaining ecological balance or stability, to actions that “maximize ecosystemic excellences." Baird Callicott (1989, 31) says something similar, that the "organic whole" of the biosphere has rights to moral considerability based on "ecological entitlement." Salthe (2005, 1) speaks of the natural biological world as comprising "nested homeostatic space-time systems." De La Plante and Odenbaugh (forthcoming, 2) claim "the theoretical ecology literature" supports "a 'balance of nature' and that ecosystems exhibit self-organizing behaviors that are directed toward increasing complexity and stability." Although Odenbaugh (2005, 250) admits that concepts of stability and balance are vague, he maintains that "ecological stability" provides a "conceptual framework for ecologists to study communities in the field and the lab."

However, the biggest problem with environmental ethicists such as De La Plante, Odenbaugh, and Rolston—all of whom appeal to some sort of ecological homeostasis or balance of nature—is that there is no clear, confirmed sense in which natural ecosystems proceed toward homeostasis, stability, or balance. As a result, ecologists have rejected the diversity-stability view held by MacArthur, Hutchinson, and others. Indeed, there are dozens of empirically-based counterexamples to various ecological-stability claims, e.g., Paine and Levin (1981), May (1973), Levins (1974, 123–138), Connell (1978, 1302–1310), and others (e.g, Sagoff 1985, 107–110) have challenged them on both mathematical and field-based grounds. The result? Given that natural ecosystems do not proceed toward homeostasis, stability, or balance, the only uncontroversial basis for condemning actions such as species destruction are case-specific and precautionary—thus anthropocentric (e.g., the wrongness of wanton destruction or carelessness), as we shall argue later. The reason? There are no clear, confirmed universal theories of ecological "balance" that can be used to condemn environmental "damages." Thus, one can support an environmental ethics, but not on the basis of some predictive, general, ecological theory—some "hard ecology." The situation in ecology is thus a bit like that in medical science, in which one also might try to define criteria for what is “balanced” or “healthy.” Ecology is unlike medical science, however, because medicine’s goal is always the welfare of the individual patient, whereas the goal of ecology is the welfare of some whole or system—a far more difficult goal to specify because one cannot precisely define the whole that is being “balanced.” Is it species, several species, communities, populations, an ecosystem, selected ecosystems, or the biosphere? All of these entities are also continually changing—making them not amenable to precise specification—or what I call “hard ecology,” in large part because the natural-selection foundations of ecology undercut any uncontroversial notion of ecosystem holism, equilibrium, balance of nature, or species (Shrader-Frechette and McCoy 1992; Sober 2006; Calsbeek et al. 2009).

Moreover, because ecology is more empirically and theoretically underdetermined than many other sciences, it cannot provide clear, precise directives for environmental ethics. In island biogeography, for example, there are many areas of under-determination that require one to make choices among different methodological value judgments. These choices concern how to interpret data, how to practice good science, and how to apply theory in given situations, such as determining the best design for nature reserves. Such choices are evaluative because they are never wholly determined by the data. In the nature-reserve case, as already mentioned, ecologists must decide whether ethical and conservation priorities require protecting an individual species, an ecosystem, or biodiversity, when not all can be protected at once. Different design choices are usually required to protect a particular species of interest, as opposed to preserving a specific ecosystem or biotic diversity. Also, ecologists often must choose between maximizing present and future biodiversity. Currently, they are able to determine only which types of reserves, for example, contain the most species at present, not which ones will contain the most over the long term. Besides, in the absence of adequate empirical data on particular taxa and their specific autecology, ecologists must frequently decide how to evaluate the worth of general ecological theory in dictating a preferred reserve design for a particular case. They are also often forced to assess subjectively the value of different reserve shapes. Besides, reserve shape, as such, may not explain variation in species number (e.g., Hansen and DeFries 2007, Simberloff and Cox 1987; Williamson 1987; Boecklen and Simberloff 1987; Blouin and Conner 1985).

Ecologists likewise must frequently rely on subjective estimates and methodological value judgments whenever the "minimum viable population" size is not known in a precise area (Boecklen and Simberloff 1987). One of the most fundamental sources of value judgments in ecology is the fact that the island-biogeographical theory underlying current paradigms regarding reserve design has rarely been tested and is dependent primarily on correlations rather than causal explanations, on assumptions about homogeneous habitats, and on unsubstantiated turnover rates and extinction rates. Hence, whenever ecologists apply this theory, they must make a variety of methodological—and sometimes ethical—value judgments. Some of these value judgments concern the importance of factors other than those dominant in island biogeography (for example, maximum breeding habitat), factors that have often been shown to be superior predictors of species number. Making value judgments regarding reserve design is also difficult because corridors (an essential part of island biogeographic theory) have questionable overall value for species preservation. Recommending use of corridors thus requires ecologists to evaluate subjectively their effectiveness in particular situations. Also, owing to the large variance about species-area relationships, those who use island biogeographical theory are often forced to make subjective evaluations of non-testable predictions. Some of these subjective evaluations arise because islands are disanalogous in important ways with nature reserves. As a result, ecologists who apply data about islands to problems of reserve design must make a number of value judgments about the representativeness and importance of their particular data (e.g., Stouffer et al. 2011; Ale and Howe 2010; Shrader-Frechette 1995; Shrader-Frechette and McCoy 1993; Boecklen and Simberloff 1987).

Because of the empirical and theoretical underdetermination exhibited by ecological theories like island biogeography, and because of the resultant methodological value judgments necessary to interpret and apply it in specific cases, ecology does not appear to be "hard" enough or solid enough to be fully amenable to providing uncontroversial support for environmental ethics and policy. Ecology's value judgments break the deductive connections of scientific theory. Of course, there are rough generalizations and case studies that can aid problem-solving in specific ecological situations, as a prominent United States National Academy of Sciences report recognized (Orians et al. 1986). This report remains the classic, latest source of information on ecological method. However, rough ecological generalizations and ecological case studies provide no uncontroversial support for environmental ethics, precisely because they can be challenged on grounds of subjective judgments, lack of general theory, and inability to replicate the findings (Shrader-Frechette 1995; Shrader-Frechette and McCoy 1994).

A second reason—in addition to the underdetermined, value-laden theory—why precise, universal, hypothetico-deductive laws are unlikely in ecology, is that fundamental ecological terms (like 'community' and 'stability') are imprecise and vague. As a result, they are unable to support precise empirical laws, although there are many useful ecological models (e.g., Clark and Mangel 2000). Likewise, though the term 'species' has a commonly accepted meaning, and though evolutionary theory gives a precise technical sense to the term, there is no general agreement in biology on an explicit definition of 'species'. There is consensus neither on what counts as causally sufficient or necessary conditions for a set of organisms to be a species, nor on whether species are individuals. Phenetic taxonomy has failed to generate a workable taxonomy, perhaps because species are not natural kinds and because facts cannot be carved up and rearranged in accordance with the hopes of numerical taxonomists (e.g., Stamos 2003).

Ecology, more empirically and theoretically underdetermined than many other sciences, cannot provide clear, precise directives for environmental ethics

Simple, general, precise, hypothetico-deductive laws are also unlikely in ecology because of the uniqueness of ecological phenomena. If an event is unique, it is typically difficult to specify the relevant initial conditions for it and to know what counts as relevant behavior. One must often have extensive historical information in order to do so. Hence, from an empirical point of view, complexity and uniqueness hamper the elaboration of a simple, general set of hypothetico-deductive laws to explain most or all ecological phenomena.

At the other extreme from "hard ecology," proposed "soft ecology" likewise fails to provide adequate scientific foundations for environmental ethics because concepts like "integrity" are qualitative, unclear, and vague. These "soft ecology" terms underestimate the ecological uncertainty associated with such fuzzy terms. Arne Naess (1973) recognized this point when he claimed that the normative foundations provided by ecology are merely "basic intuitions." The problem with intuitions is not only that they are vague and qualitative but also that one either has them or does not. They are not the sort of things amenable even to intelligent debate, much less to scientific confirmation or falsification. Hence, intuitions ask too little of ecology; their uncertainty causes us to come up short when ecologists need to defend their conclusions in an environmental courtroom.

To illustrate the difficulties with this intuitive "soft ecology," consider some of the problems associated both with the scientific foundations of the concept of ecosystemic integrity and with its philosophical applications. Much of the scientific and ethical interest in integrity arose as a result of the famous environmental precept of Aldo Leopold (1949, 224–35): "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise." Numerous environmental ethicists have done analyses of the concept of ecosystem integrity (e.g. Odenbaugh 2005; De La Plante 2004; Noss, Westra, and Pimentel 2000; Callicott 1982; Rolston 1975), and De La Plante and Odenbaugh (forthcoming, 2), for instance, claim "that ecosystem theory legitimizes such notions as 'ecosystem health' and 'ecosystem integrity.'" Unfortunately, however, these studies rely on problematic science or soft ecology—that is unable to adequately support environmental ethics. What are the problems?

Leading experts on ecosystem integrity, such as Henry Regier and James Kay (Regier 1992; Waltner-Toews and Kay 2002; Kay and Regier 2000) admitted that the term has been explicated in a variety of ways: to refer to open-system thermodynamics, to networks, to Bertalanffian general systems, to trophic systems, to hierarchical organizations, to harmonic communities, and so on. Obviously, a clear, operational scientific concept cannot be explicable in a multiplicity of ways, some of which are mutually incompatible, if one expects the concept to do explanatory and predictive duty for field ecologists and therefore philosophical and political duty for attorneys, policy-makers, and citizens involved in environmental controversies.

A second problem with ecological-integrity concepts is that when people attempt to define "integrity" precisely, often the best they can do is specify necessary conditions, such as the presence of "indicator species" for ecosystem integrity. For example, the 1987 Protocol to the 1978 Great Lakes Water Quality Agreement formally specified lake trout as an indicator of a desired state of oligotrophy (Regier 1992). One difficulty—with using such species to indicate environmental integrity—is in part that tracking the presence or absence of an indicator species is imprecise and inadequately quantitative. A better idea might be to track the change in species number or taxonomic composition. Another recognized problem is that the presence or absence of an indicator species alone presumably is not sufficient to characterize everything that might be meant by "integrity;" otherwise, people would not speak of "ecosystem integrity" but merely of "ecosystem presence of lake trout." Hence, though the meaning of "integrity" is not clear, defining the term via several indicator species appears both crude and inadequately attentive to the underlying processes likely contributing to the presence or absence of certain species and to the larger processes presumably possessing integrity (e.g., Farr 2002; Shrader-Frechette 1995).

The objections here are not to philosophical or ethical concepts of integrity or balance—which obviously may have heuristic and political power. Rather, the argument is that philosophers and soft ecologists do not call a spade a spade. They do not call soft science "soft" when it is soft, and they appear not to realize that ecology cannot meet the demands of "hard" science. They also appear not to realize that soft science, in the absence of an environmental political consensus, is unlikely to be robust enough to support precise environmental ethics and policy decisions. When a consensus supports particular environmental values, then soft ecology is obviously valuable and heuristically useful, despite the absence of "hard ecology." But situations of consensus regarding environmental values are not those in which we most need ecology. For all these reasons, ecological theory is not an adequate basis for environmental policy-making. At best, it provides necessary, but not sufficient, scientific grounds for environmental ethics and policy. Insofar as it is uncertain and requires us to fill in our knowledge gaps with subjective judgments, it leads to incomplete hard ecology or question-begging soft ecology—neither of which can adequately support environmental ethics and policy.

Ecological theory provides necessary, but not sufficient, scientific grounds for environmental ethics and policy

SIMPLISTIC APPEALS TO BIOCENTRISM AND INTRINSIC VALUE IN ENVIRONMENTAL ETHICS

If ecological theory cannot provide a complete, uncontroversial basis for environmental ethics, what other resources can philosophers and ethicists provide? Are these philosophical resources adequate? This portion of the chapter attempts to answer both questions.

In the early 1970s, environmental ethics began by challenging traditional human-centered, or anthropocentric, ethics and the supposed moral superiority of humans to other beings (e.g., Stone 1974). As subsequent paragraphs reveal, many environmental ethicists argued that, instead of individual humans, the key subjects of value are ecological wholes, such as ecosystems; other environmental ethicists argued that the main subjects of value are natural things, from roaches to rocks, all of which have intrinsic value or value in themselves, apart from human considerations—or non-instrumental value, value as more than mere means to human ends.

A few environmental ethicists, however, relied on traditional ethics to challenge environmental abuses, arguing that factors such as greed and consumerism harm both humans and the natural environment (e.g.,Passmore 1974; Shrader-Frechette 1981; Norton 1991; de Shalit 1994; Light and Katz 1996). Many of these more traditional or more pragmatic environmental ethicists are anthropocentrists only in the weak sense because they believe that beings, other than humans, also have intrinsic value. (Anthropocentrists in the strong sense believe that only humans have intrinsic or non-instrumental value—value in themselves, independent of their utility to others.) Most philosophers believe that if a being has intrinsic value, then others have *prima facie* duties to protect it or refrain from harming it (O'Neil 1992; Jamieson 2002). Consequently, it is crucial to know whether only humans have intrinsic value. Aristotle (1948, Bk. 1, Ch. 8), for instance, is a strong anthropocentrist who claims that "nature has made all things specifically for the sake of man" and that the value of nonhuman things in nature is merely instrumental. Thomas Aquinas (1975, Bk. 3, Pt. 2, Ch. 112) likewise claims that nonhuman animals are "ordered to man's use." Weak anthropocentrists, however, believe that humans have greater intrinsic value than other beings, or that in cases of conflicts, human well-being often outweighs that of other beings. Immanuel Kant (1963) explains that humans (or what we here call "strong anthropocentrism") need not ignore non-humans, however, because cruelty to other animals is wrong insofar as it might encourage people to become desensitized to cruelty towards humans.

Many environmental ethicists—who affirm the intrinsic value of all beings—also subscribe to "biocentrism." That is, they claim that the welfare of the biosphere, rather than that of humans alone, is the key to environmental ethics. Yet each environmental ethicist defines "biocentrism" in slightly different ways. Aldo Leopold (1949, 224–225), for instance, maintained that an action is right when it tends to preserve the integrity, stability, and beauty of the biotic community, but he offered no ethical theory to justify his position. Building on Leopold, Richard Routley (1973; Routley and Routley 1980) argued that typical Western anthropocentric ethics amount to "human chauvinism," blind "loyalty" or prejudice, and thus discriminates against those outside the privileged human class. Baird Callicott (1989) argues for a *holism* based on Leopold's view that "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community ...," and Callicott takes this as the supreme deontological principle for ethics. For Callicott, only the earth's biotic community has intrinsic value, and the value of individual members is merely instrumental to their contribution to the "integrity, stability, and beauty" of the larger biotic community. Biocentrist Paul Taylor (1986, 1981; see Agar 2001), however, defends a more individualistic version of biocentrism and the intrinsic value of nature. He argues that each living thing in nature is a "teleological-center-of-life" that has a well-being of its own and that all beings who are teleological-centers-of life have equal intrinsic value (what he calls "inherent worth"). As a result, Taylor says they deserve moral respect. For example, he says this "inherent worth" means therefore that humans have a *prima facie* duty (a duty accepted until there are compelling reasons to the contrary) to promote the biological good—or inherent worth or intrinsic value—of these beings, as ends in themselves. Agreeing, De La Plant and Odenbaugh (2005, 2) claim that "the theoretical ecology literature" justifies such "holistic conceptions of nature."

However, despite their differences, environmental ethicists' appeals to biocentrism and the equal intrinsic value of nature have at least four major problems. *First*, as already argued in section one, and contrary to ethicists such as Callicott, De La Plante and Odenbaugh, ecological theory does not clearly justify any notion of biocentrism or the inherent worth of nature. A *second* problem with biocentric theory is that, contrary to Taylor, Callicott, and most other biocentrists, "biological good" is merely descriptive, not prescriptive (see Williams 1992 and O'Neill 1993, Ch. 2). Consequently, there are no obvious moral grounds for realizing that good. A *third* problem is that, if Callicott and others are correct, then any individual member of the biotic community could be sacrificed in order to protect the supposed integrity, beauty, or stability of the biotic community. In short, Callicott's early views, and other biocentric views can lead to "environmental fascism," sacrificing humans for the sake of some supposed reason of environmental welfare (Regan 1983, 362; Shrader-Frechette 1996)—a fact that led Callicott to affirm the intrinsic value of all individuals in the biotic community, as well as that of the community itself. While this response of Callicott avoids the charges of "environmental fascism," it leads Callicott into the fourth problem, outlined below. Warwick Fox (2007), however, continues to give top moral priority to ecosystems and the biophysical world, a fact that makes him vulnerable to the charge of environmental fascism.

One of the most basic difficulties with all biocentric environmental ethics—at least those that claim all beings have equal intrinsic value—a *fourth* problem, is operational. The operational problem is that these ethics are incomplete because they provide no second-order or *ultima facie* criteria (criteria, all things considered) to adjudicate among the different interests of different beings. Which and whose interests should be primary in cases of conflicts in biocentric ethics? In conflicts among humans, humans are assumed to be equal, but considerations of merit, blame, negligence, compensation, and so on help ethicists and policy-makers decide whose interests ought to be accorded primacy in a given situation. In conflicts among humans, animals, and plants, however, there are no obvious, uncontroversial second-order principles because principles of merit, blame, negligence, compensation, and so on, apply only to beings with free will, who are capable of being moral agents. Bees cannot be "blamed" for stinging people, although people can be. Virtually all philosophers thus recognize that, because there are no easy, exception-free definitions of such *ultima facie* claims to have one's interests protected, such protection must rely merely on *prima facie* claims—the very claims to which most environmental ethicists appeal.

However, such *prima facie* claims are not operationalizable unless one knows when they translate into *ultima facie* claims. For the reasons just given, one does not know these things, and biocentrism and "equal interests" fail to provide an adequate foundation for environmental ethics.

Many environmental ethicists also subscribe to "biocentrism." That is, they claim that the welfare of the biosphere, rather than that of humans alone

A *fifth* major problem with environmental ethicists' biocentrism is that it is both empirically unfounded and can lead to elitism and insensitivity to human needs, as when Garrett Hardin or Holmes Rolston (1996) claim that some humans are cancers on the planet, especially in developing nations where the need to feed people often results in environmental destruction. Yet poor people are often excellent environmental managers who do less environmental damage than most Westerners. Indeed, Westerners seem mainly responsible for the environmental crisis (Martinez-Alier 2002; Attfield 1998; Brennan 1998a; Guha 1989; Shrader-Frechette 1981).

THREE SOLUTIONS

Given all the problems with ethicists' misguided appeals to ecological laws, to biocentrism, and to equal interests, what are possible solutions? At least three come to mind: 1. ethical default rules to use in situations of ecological uncertainty, 2. scientific-case-study environmental ethics, and 3. recognizing human rights against life-threatening pollution.

Because there is so much obvious uncertainty in ecological science, one solution for environmental ethicists and policy-makers is to adopt an ethical-default rule. As a default principle for dealing with uncertainty, European Union law and many medical and citizens' groups, including the American Public Health Association (APHA), advise adopting the "Precautionary Principle." APHA formulates the principle as the claim that situations characterized by potentially life-threatening uncertainty should be assumed harmful until proved safe. According to this principle, one should try to prevent potentially serious environmental and public-health harm, even before all the details are known about them. The rationale is that, if one waits for potentially serious harm to become obvious or widespread before doing anything about it, it often is too late to stop the harm. As a result, AHPA recommends treating all chemicals as dangerous until they are proved otherwise. Following this principle not only protects humans and the environment against potentially serious threats but also provides an incentive for reducing future uncertainty. If polluters know that, in the absence of reliable data about their pollutants and products, government will follow the Precautionary Principle, they will be less likely to prolong uncertainty or discourage doing the requisite scientific studies.

Three solutions come to mind: 1. ethical default rules to use in situations of ecological uncertainty, 2. scientific-case-study environmental ethics, and 3. recognizing human rights against life-threatening pollution

A related precautionary procedure is to minimize type II, rather than type I, statistical errors under conditions of uncertainty when both errors cannot be avoided. Contrary to current scientific norms, this default procedure places the burden of proof not on anyone who posits an effect, but on anyone who argues that there will be no damaging effect from a particular environmental action. One can defend this rule, despite its reversal of the norms of statistical practice, on straightforward grounds of protecting human welfare. After all, humans take precautions such as getting medical check-ups, buying insurance and carrying umbrellas just in case it rains. Humans do not wait for harm to threaten them before they take action to prevent it, and the same reasoning applies to justify all default principles in environmental ethics (Shrader-Frechette 2007, ch. 6, 1993; Fisher, Jones, and Schomberg 2006; Ricci et al. 2003).

A second means of improving environmental ethics and policy would be to base it on the "practical ecology" of case studies, even though case studies do not rely on general theory. Case studies are grounded on rules of thumb (like the norm regarding types I and II statistical error), on rough generalizations, and on detailed investigations of individual organisms. A classic National Academy of Sciences (NAS) committee illustrated how case-specific, empirical, ecological knowledge, rather than an uncertain general ecological theory or model, might be used in environmental problem-solving (Orians et al. 1986). According to the NAS committee, ecology's greatest predictive successes occur in cases that involve only one or two species, perhaps because ecological generalizations are most fully developed for relatively simple systems. This is why, for example, ecological management of game and fish populations through regulation of hunting and fishing can often be successful. Applying this insight to this discussion, ecology might be most helpful in undergirding environmental ethics and policy-making when it does not try to predict complex interactions among many species, but instead attempts only to predict what will happen for only one or two taxa in a particular case. Predictions for one or two taxa are often successful because, despite the problems with general ecological theory, there are numerous lower-level theories in ecology that provide reliable predictions. Application of lower-level theory about the evolution of cooperative breeding, for example, has provided many successes in managing red-cockaded woodpeckers. In this case, successful management and predictions appear to have come from specific information, such as data about the presence of cavities in trees that serve as habitat. Examples like that of the woodpecker suggest that, if the case studies used in the NAS report are representative, then some of the most successful ecological applications arise when (and because) scientists have a great deal of knowledge about the specific organisms investigated in a particular case study. As the authors of the NAS report put it, "the success of the cases described … depended on such information" (Orians et al. 1986, 506ff.; Shrader-Frechette and McCoy 1994; Shrader-Frechette 1995; Miao et al. 2009).

Third, one also might improve environmental ethics and policy by tying public health and environmental concerns together—by motivating environmental concern through encouraging awareness of how environmental pollution and destruction also harm humans. How does environmental pollution, for instance, harm humans? The United States National Cancer Institute (NCI) attributes about 10% of cancer deaths (about 60,000 annually, just in the United States) to industrial pollution in workplaces, public areas, and consumer products (HHS, NCI 1991). This figure has also been confirmed in 2005 United States National Academy of Sciences studies (McGinnis 2005). Claiming this NCI figure is too low, some environmental scientists say these same industrial pollutants cause up to 33% of all United States cancers (Ehrlich and Ehrlich 1996, 154). United States health, education, and welfare reports are even more damning. Some of them say 38% of all cancers are caused by only five high-volume industrial carcinogens (Bridbord et al. 1978). Even if the lowest of these estimates is correct, it points, at least, to a public health problem and an ethics problem. The public health problem is that we humans are killing ourselves with environmental pollutants although these deaths are "theoretically preventable" (Lashoff et al. 1981, 3 and 6).

A key ethical problem with this massive pollutant-induced harm is that the fatalities are not borne equitably among the population. Consider a 2002 *New England Journal of Medicine* study, a multi-year analysis of childhood cancer among 90,000 twins. Designed to distinguish environmentally-induced cancer from those caused by genetics, infections, or viruses, the study concluded that the environment (industrial toxins but also including factors like cigarette smoke) was "overwhelmingly" implicated in causing virtually all of childhood cancers (Lichtenstein et al. 2002). Although many adults have defenses against premature disease and death caused by air, water, and other environmental pollution, children do not. Their developing organ systems, incomplete metabolic processes, and only partially developed detoxification systems are less able to withstand most toxins; yet per unit of body mass, children take in more air, water, and food (and thus more pollutants) than do adults (UNICEF 2006). Also, because many pollution regulations focus on cancer and only on adults, they ignore pollution-induced developmental and neurological disorders in children. United States National Academy of Sciences studies show that "exposure to neurotoxic compounds [like pesticides] at levels believed to be safe for adults can result in permanent loss of brain function if it occurs during the prenatal and early childhood period of brain development" (NRC 1993, 61).

In general, children are at least 10 times more sensitive to any pollutant than are adults, yet for some pollutants, like organophosphate pesticides, a lethal dose in immature animals can be only 1% of the lethal dose for adults (Spyker and Avery 1977). Similarly, neurodevelopmental disorders such as autism, attention-deficit hyperactivity disorder (ADHD), mental retardation, and cerebral palsy are increasing, are very costly, cause lifelong disability, and are known to be associated with industrial chemicals such as lead, methylmercury, polychlorinated biphenyls (PCBs), arsenic, and toluene. Exposure to these and other chemicals during early fetal development can cause human brain injury at doses much lower than those that harm adult brain function (Grandjean and Landrigan 2006). The American Public Health Association thus warns that because "children are often more susceptible to environmental contaminants than adults," and because government "policies and decisions" often fail to reflect this "unique susceptibility," children have "particular need for special protection from pollutants" (APHA 2000, pol. 200011). Yet, most nations of the world fail to give children this protection and thus subject them to environmental injustice, that is, to unequal and unjust pollution impacts. For instance, *Lancet* authors say that particulate air pollution alone annually causes 6.4% of children's deaths, ages 0–4, in developed nations; in Europe, this means that air particulates, alone, kill 14,000 toddlers each year (Valent et al. 2004). The World Health Organization says air pollution alone is associated with up to half of all childhood cancers (WHO 2005, 155). As a consequence of children's greater sensitivity to pollutants, although cancer is increasing 1% per year for adults, the annual rate of increase for children is 40% higher—1.4% per year (Devesa et al. 1995; Ries et al. 1998; Epstein 2002). Children are thus "the canaries in the coal mines" of industrial emissions.

How should people respond to this disproportionate environmental harm borne by the most vulnerable members of society, children, as well as by the environment? To the degree that individuals have participated in, or derived benefits from, social institutions—such as poor government pollution controls—that have helped cause life-threatening or rights-threatening environmental harm, one can argue that these individuals have *prima facie* duties either to stop their participation in such damaging institutions or to compensate for this harm by helping to reform the institutions that allow the harm. (*Prima facie* duties are those that one has, in the absence of specific arguments to the contrary.) Yet, virtually everyone in the developed world—who enjoys at least a middle-class lifestyle—has participated in, or derived benefits from, social institutions—such as poor government pollution controls—that have helped cause life-threatening or rights-threatening environmental harm. Why are so many of us responsible for pollution harm?

In virtually every nation of the world, poor people, minorities, and children bear greater pollution burdens than the rest of the population—the middle-class population, especially in developed nations. Proportionately more landfills, power plants, toxic-waste dumps, bus and rail yards, sewage plants, and industrial facilities are sited in the neighborhoods of poor people and minorities; as a result, they bear higher levels of cancer, preventable death, infectious disease, contaminated air and contaminated tap water. Thus, "exposure to environmental risks varies based on race and … income" APHA 2005). For instance, in virtually all nations, middle-class people have their garbage removed to the neighborhoods of poor people, where it is burned or buried and causes harm. Or, for instance, poor people and minorities live in more polluted areas because wealthier people can afford not to do so. Wealthier people and adults thus "buy their way" out of many problems of environmental pollution. They are able to do so because wealthier people can pay attorneys and scientists to help them avoid noxious facilities in their own neighborhoods, whereas poor people cannot. As a result, wealthier people are able to impose these environmental burdens on the poor, through environmental injustice (Shrader-Frechette 2007, 2002; Bryant 1995; Bullard 1994).

But if people have *prima facie* duties to compensate for the life-threatening, rights-threatening, and unequal distributions of environmental pollution from which they unfairly benefit, one can argue that this compensation ideally ought to take the form of helping to reform social institutions that contribute to life-threatening environmental pollution and environmental injustice. As such, this argument relies on two basic claims about different types of responsibility. One claim is that if citizens have unfairly benefited from and therefore contributed to unequal pollution harm, they bear *ethical responsibility* for helping to stop it. The second claim is that if citizens live in a democracy, and therefore are entitled to participate in nations and institutions whose environmental policies and practices contribute to pollution harm and to environmental injustice, they also have *democratic responsibility* to help stop it. Although there is no space to develop this full argument here, it has been developed elsewhere, along with answers to objections to it. It clearly shows that people who are at least middle class, especially in developed, democratic nations, have duties to help stop life-threatening pollution harm, and that these duties bind us because people have basic human rights to equal consideration. Those who contribute to unequal pollution-protection consideration—as many do, by virtue of imposing pollution burdens on the most vulnerable members of society, such as poor people, minorities, and children—obviously have duties of compensatory justice to their fellow humans—duties that also would go a long way toward protecting the environment (Shrader-Frechette 2007, 2002)

CONCLUSION

The modest, practical, environmental ethics for which we have argued relies on the practice of ecologists and on their individual cases and on unavoidably human, but well-substantiated and non-stipulative judgments about environmental management. Ecology, however, may not be seriously flawed because it must sacrifice universality for utility and practicality, or because it must sacrifice generality for the precision gained through case studies. Similarly, environmental ethics is not flawed because it must rely on solutions that rely on ethical default rules and on combining human rights and public health progress with environmental progress and protection. Traditional ethics can give us powerful weapons for defending the environment.

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>> Despite its importance in addressing the widespread global destruction of nature, contemporary environmental ethics often relies on two misguided claims. These are 1. that ecology provides reliable scientific laws for remedying environmental destruction; 2. that environmental ethics should be biocentric, not anthropocentric, and therefore that nonhuman beings should be accorded equal consideration of their interests, just as humans are. However, among other reasons, 1. is scientifically false because ecology has no such deterministic laws, and 2. leads to "environmental fascism" and provides for no second-order criteria to adjudicate among different interests and rights of different beings. Instead of these questionable claims, the chapter argues for three new principles—based on ethical default rules, scientific-case-study ethics, and human rights against pollution.

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