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Environmental Science and Environmental Advocacy: From 'Is' in Science to 'Ought' in Ethics

Science and conscience have a complex, elusive relationship, nowhere better illustrated than in the relationship between environmental science and environmental ethics. Each can inform the other to connect facts with values, descriptions with prescriptions, to make advocates out of scientists and scientists out of advocates. Making these connections, always important, is more urgent than ever; indeed, the future of the planet and all those who reside on it, depends on joining science and conscience.

Environmental science and environmental ethics

An environmental ethic is foolish not to be informed by the best environmental science available. The success of an environmental policy does not depend merely on the cultural values, the policy preferences, or the social institutions that drive the human actors. Success depends on coupling such prescriptive values with an environmental science that is descriptively accurate and operationally competent. American culture greatly values the bald eagle as a national symbol. But we cannot save this endangered species unless we know what eagles eat, where they migrate, where they nest, and what pesticides and herbicides build up in the food chain and end up toxic to the eagles. Getting these facts right, and making them available for decisions, is the first responsibility of environmental scientists.

In this sense an environmental ethic, more than traditional ethics, needs to escape cultural relativism. True, cultures have some options in what they value in nature; Americans chose the eagle as a symbol, the British the lion. It is equally true that nature exists outside culture; wild nature is what it is regardless of either environmental science or environmental ethics. Environmental science must communicate to environmental ethics the parameters within which ethics must work. So environmental ethics must place at least one foot outside culture. The way the world ought to be depends on the way it can be, and that depends on the way it is.

This becomes problematic when a socially-held value drives a mistaken environmental science. We have to be cautious about thinking that science is canonical, for we know that science changes, sometimes rapidly. Anyone versed in the history of science is impressed with the depth of these changes. There is no reason to think that the science of tomorrow will not be different from the science of today. Sometimes these misperceptions of the way nature works are driven by social values. Nor is it easy to say, when perceptions change, whether new values permit new perceptions or newfound perceptions generate new values.

The U. S. Forest Service for the first half of this century designed and conducted research projects that proved its claim that fire was a destructive agent in forests and should be suppressed.[1] Fire policy followed accordingly. This claim about fire in forests was largely driven by the economic value of timber. Over the last thirty years we have revalued fire. One ought to let natural fires burn; one ought to set prescribed fires. What brought about the changed ethic? Better environmental science. A skeptic may say that today we only have different social values driving a different environmental science, and another mis-perception. But if so, the challenge remains; we cannot form a prescriptive environmental ethic about fire until we are descriptively informed about fire ecology. What culture ought to do depends on what is the case in nature.

Descriptive *'Is'* and Evaluative 'Ought'

Environmental science informs environmental ethics in more subtle ways. Consider some descriptive categories used of ecosystems: the *order, stability,* and *diversity* in these biotic *communities.* We describe their *interdependence,* or speak of their *health* or *integrity,* perhaps of their *resilience* or *efficiency.* We describe the *adapted fit* that organisms have in their niches, the roles they play. We describe an ecosystem as *flourishing.* Strictly interpreted, these are just descriptive terms; and yet often they are already quasi-evaluative terms. Order, stability, diversity, interdependence, fitness, health, integrity are values too–perhaps not always so but often enough that by the time the descriptions of ecosystems are in, some values are already there. They are among the givens, not the options.

Matters might have been different. If the descriptions were of disorder, instability, impoverished numbers of species, misfits, pathological relationships and self-degrading systems, we should have to make other judgments. And, sometimes this seems to be so in nature. Still, often the seeming disvalues, on deeper appreciation, are misperceptions or half truths. As just noted, we long thought that fire was a disvalue. Earlier, there was a debate about whether ecosystems were real communities or merely fortuitous aggregations; and the

facts here affect our value judgments. In the last decade debate has increased about the extent to which the evolutionary history of ecosystems is contingent, even chaotic, and the answers will affect our value judgments. If speciation is only by random accident and drift, not really involving adapted fit and biological achievement, we might value the diversity of species less.

The biological sciences, including the ecological sciences, do describe what is the case in nature and enable us better to appreciate and conserve it. Science does this better than folklore, mythology, and, often, than religious beliefs. These natural events are not processes that go on in the human mind, they are not at our option or preference, but they are objectively there in the world, and we have to discover them, not choose or assign them. We conserve natural things because they are useful, but also because we marvel at the intricacy, diversity, complexity, beauty, order, natural history, at the creativity present in nature. So we have both to take care that our ethics is informed by the facts about nature, and, since these facts reform our value judgement, we have to take care that our science is sensitizing us to the values there. Bad science can result in bad ethics. Good science is a prerequisite for good ethics.

Ecologists and a sustainable biosphere

Ethics can sometimes inform science. We will consider two cases, both from professional scientific societies, one from ecology, which has traditionally been reckoned among the pure sciences, one from forestry, traditionally one of the applied sciences.

A scientific group, the Ecological Society of America, has advocated research and policy that will result in a sustainable biosphere. The ESA, in a document that it calls "unprecedented in its scope and objectives" sets a policy "to define research priorities for ecology in the closing decade of the 20th Century." Those priorities are, in brief, a "sustainable biosphere".[2] "Achieving a sustainable biosphere is the single most important task facing humankind today".[3] "There is no higher priority for research".[4]

Here we have, right up front, a value-driven science: one ought to sustain the biosphere. This might be, vis-a-vis nature, either a prudential or a moral ought, or both. Such advocacy might, for an individual human agent, be a prudential ought, since every human has a self-interested stake in the condition of the environment that one inhabits. But such policy must be, vis-a-vis other humans, a moral ought, since other humans are helped or hurt by the condition of the environment

Further, beyond human welfare, this policy statement can involve—indeed the ESA statement everywhere allows for—a caring for the biosphere because it has value in itself. The ESA report is nicely comprehensive (some would say

deliberately evasive) about the mix of anthropocentric and intrinsic natural values. A research priority is to understand "how to manage ecological systems so that they can remain productive to support natural processes and the human population." Research is "for the specific purpose of prescribing the most effective restoration and management strategies to ensure the continuance of Earth's ecological systems".[5]

So there are multiple levels of value at stake here. One can advocate both saving values that are intrinsic in these ecosystems, independently there whether or not humans are interested, and also advocate values instrumental to humans who depend on these ecosystems. Scientists and ethicists can take it either way, or both ways. But there is only one way to interpret the word "prescribe." That is an ethical word driving the agenda of science. This is mission-oriented research.

Notice that the priority set is not "sustainable development," not that set at the Earth Summit, at least not exactly. The focus is different. The United Nations World Commission on Environment and Development makes sustainable development a first priority. The Brundtland Report gives "overriding priority" to the needs of the poor and to growth, within the limits and powers of technology and social organization, growth that can be environmentally sustained.[6] The Ecological Society of America advocates, rather, a caring for nature that sustains the biosphere, and any sustainable human development must come within those more fundamental parameters. The report laments, in fact, an emphasis on sustainable commodities, sustainable agricultural and industrial production. "Much of the current research focuses on commodity-based managed systems, with little attention paid to the sustainability of natural ecosystems whose goods and services currently lack a market value".[7]

The Commission on Life Sciences of the National Academy of Science, in a position statement, was more humanistic about it: "We must... restructure our scientific objectives toward the goal of assisting human societies to preserve their global bio-geological life support systems".[8] Humans care about nature only insofar as it is *their* life support. Still, the NAS position is value-laden and moral. In this imperative restructuring, the NAS "must" is prudential from the collective viewpoint of humans, but it is moral from the viewpoint of those scientists urged to restructure their objectives.

A forest ethic and sustainable forestry

Foresters typically think of themselves as doing applied science, while ecologists may do pure science. The Society of American Foresters has recently adopted a new land ethic statement. Termed a "land ethic canon," the statement was approved by 77% of those voting by mail referendum ballot in the fall of

1992, about 6,000 of the 12,000 members of the Society; or a 3 to 1 margin. The new ethic reads, with the new language underlined:

> *Stewardship of the land is the cornerstone of the forestry profession.* The purpose of these Canons is to govern the professional conduct of members of the Society of American Foresters in their relations with *the land*, the public, their employers, including clients, and each other as provided in Article VIII of the Society's Constitution. Compliance with these Canons *demonstrates our respect for the land and our commitment to the wise management of ecosystems,* and ensures just and honorable professional and human relationships, mutual confidence and respect, and competent service to society. (Preamble)
>
> *A member will advocate and practice land management consistent with ecologically sound principles.* (Canon I)[9]

Considerable debate underlies these carefully chosen words. Raymond S. Craig, chair of the SAP Land Ethic Task Force, explains, "Most foresters aren't comfortable with espousing philosophy! We don't usually use words like "respect" and "love" in our everyday work.Yet foresters invariably use these words when asked to explain how they feel about the forest, particularly when discussing the reasons that led them to choose this profession." "The challenge lies in expanding our role beyond commodity production to embrace management in consideration of other values.[9] Foresters now follow the imperative of Aldo Leopold "to value all components of ecosystems, without regard to their usefulness to humans, because all components have intrinsic value. As we manage lands, those values must be considered in our decisions".[10] Craig expressed his hope that "the land ethic would permeate the soul of the [SAF] organization. It becomes a part of all that professional foresters represent and what they say".[11]

The foresters, interestingly, considered and withdrew a proposed canon that read "A member will manage land for long-term sustainability using ecologically sound principles"[12] There were repeated objections that what was to be sustained was unclear. It might mean sustainable timber production, a commodity; or it might mean sustainable ecosystems. Many felt that forestry had too long been rhetorically committed to sustainable timber production (often more rhetoric than actuality), and unless what was sustained was more than commodity production, the land ethic would be undermined. Presumably the forester's ethical respect for the land will require that they sustain forest ecosystems as biotic communities, not simply as commercial commodities. The foresters have also advocated biodiversity: "Maintaining biological diversity is essential for sustaining the production of both commodity and non-commodity values from forests".[13] Surely too, research done henceforth in forestry will need to conform to this land ethic prescribed to all foresters.

So we see that ethics can inform both ecological science and forest science, both pure and applied. That idea stands in contrast to an older account. Con-

sider a statement by Robert G. Lee, made in the context of whether forest scientists should advocate sustaining forests by natural fires:

> We step out of our role as scientists when we prescribe actions, since actions are always goal directed and, hence, involve uncritical commitments to values and beliefs. We forfeit our role as scientists when we advocate either fire exclusion or allowing fires to burn as they would under 'natural' conditions. Scientists are most scholarly when they explain cause and effect processes, define management alternatives, or predict the consequences of alternative management actions, and leave prescription to citizen actions and public officials.[14]

Ecologists and foresters are now of a different opinion, namely, that scientists do have a role in advocating policy.

Environmental health and integrity

Ecologists and foresters come to the conviction, based on their science, that natural systems have some kind of ecological integrity or health, which are combined fact/value words. Aldo Leopold, himself both a forester and an ecologist, urged our "responsibility for the health of the land".[15] The difference between integrity and health is said by some to be that integrity applies to pristine systems, while human-modified systems can be healthy with various artificial modifications and substitutions. Many others ignore this distintinction and use the terms more or less interchangeably.

Ecology is, in a way, like medical science. Ecologists are responsible for environmental health, which is really another form of public health. Health is not just a skin-in matter, it is a skin-out matter: One cannot be healthy in a sick environment. Health is something it is easy to advocate and the criteria for health seem to be scientific. No one wants to be against sustainability, or to degrade life-support systems.

There are two possible problems with advocating health. One complaint is that the idea of health is too vague to have any operational value. Sustainablity too, along with health, is another idea that is so fundamental, so broad, so basic that neither really contains any empirical claims, but they both serve as an umbrella that covers all the interesting debates. Another problem is that "health" is being borrowed from medical environments, and possibly "health" is too organismic a term to extrapolate to biotic communities. Meanwhile, the concept works in medicine, even though health and disease are notoriously hard to define. Perhaps we need some analogous therapeutic concept in ecological science.

We use many paradigmatic concepts to conserve values: justice, freedom, love, democracy, rights, or privacy. These are system-wide words, symbols that orient us—open concepts, not always subject to calculus, but that does not

mean they are under no logical control. They give general directions. Health is like that; it is a general norm, and yet there are quite specific tests for this or that unhealthy condition. Ecologists advocate healthy ecosystems, and this may mean setting a limit of how many parts per million of dissolved oxygen is the minimum for that river. Health is closely related to sustainability. Neither human nor animal and plant life can be long sustained unless there is ongoing health.

Biological integrity is an ecosystem's ability to maintain "a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the region".[16] Biological *health* is the state in which the genetic potentials of an ecosystem's member species are realized as organisms flourish in their niches, with the integrated systemic condition dynamic and stable. The systemic capacity for self-repair when perturbed is present. "An ecological system is healthy and free from 'distress syndrome' if it is stable and sustainable—that is, if it is active and maintains its organization and autonomy over time and is resilient to stress."[17]

Descriptively, the ecosystem is functioning well; there is cycling and recycling of energy and materials. The member organisms are flourishing as interrelated fits in their niches. The system is spontaneously self-organizing in the fundamental processes of climate, hydrology, photosynthesis. There is resistance to, and resilience after, perturbation. The system does not have constantly to be doctored. "Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity".[18] In other words, ecosystem health and integrity is the key to its sustainability. If it is appropriate for physicians to promote health, then it is appropriate for ecologists and foresters to promote sustainability.

There is a problematic disanalogy, however, as yet insufficiently analysed. A person prefers bodily natural health. We repair breakdowns, but we do not rebuild the healthy body. We only go to doctors when we are sick. By contrast, we do not want entirely natural ecosystems, and nothing more. If there is to be any culture at all, especially a modern culture, we want to transform wild nature into rebuilt environments. We constantly labor to make something better out of wild nature, not just fixing something sick. The health or integrity of wild nature has to be sacrificed in the interests of developing a culture. A flourishing culture requires revamping much of wild nature. We regularly call on science and technology to help us achieve these goals. Perhaps neither ecologists nor foresters have any special competence in evaluating what rebuilding of nature a culture desires, and how far the integrity of wild nature should be sacrificed to achieve this.

However, if this goes too far, then the natural system can collapse. Scientists do have the responsibility to help us identify a pristine biological integrity,

present ideally in wilderness areas, hopefully in protected areas, and to contrast that with a culturally modified biological health, which we will try to maintain all over the landscape. This is land health, even when pristine integrity has been compromised in order to support various forms of cultural integrity. Without this kind and degree of land health, neither nature nor culture can be sustained.

Meanwhile, if these ideas can be made reasonably clear; then the connection between science and ethics is that environmental science describes land health or integrity, and environmental ethics advocates maintaining it. Here the scientist and the ethicist need not be two persons. One person can be both; a scientist ought to advocate land health. Any ethicist who advocates land health will need to learn enough science to know what he or she is talking about.

Stability and sustainability in a land ethic

Half a century ago, Aldo Leopold joined ecological science with an ecological conscience, when he urged, most famously, "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".[19] That proved a seminal claim, both for biologists and philosophers, because biologists often thought that their science was or ought to be value free, and philosophers have often thought that one commits a naturalistic fallacy to move from what is the case in science to what ought to be in ethics. Still, Leopold seemed to discover characteristics in biotic communities that served as criteria for an ethic.

Indeed, in Leopold, there was hardly any derivation of *ought* from *is*; rather, the two seemed to arise together. Ecological description found unity, harmony, interdependence, stability, integrity, and so forth, and these are valuationally endorsed. They are found, to some extent, because one searched with a disposition to value order, harmony, stability, unity. But the ecological description did not merely mirror or confirm previously existing values. It informed them, and Leopold found that the character, the empirical content of order, harmony, stability, is drawn from, no less than brought to nature.

There seemed to be a marriage and mutual transformation of ecological description and evaluation where an *ought* was discovered simultaneously with an *is*. One progressed from descriptions of fauna and flora, cycles and pyramids, stability and dynamism, to intricacy, planetary opulence and interdependence, with oppositions in counterpoint and synthesis, reaching at length beauty and goodness. It seemed difficult to tell where the natural facts left off and the natural values that one ought to conserve appeared.

But that was half a century ago. Now we face a new century. Where do we stand relating environmental science and environmental ethics? There are two

important challenges that, if not understood correctly, can threaten both the science and the ethics. Natural systems, it is often now claimed, do not have the stability earlier claimed for them. They change, and, even more problematically, these changes are contingent. This threatens first the science, and after that the ethics that was hoped to be justified by the science.

Ecology has proved a troublesome science in which to find any unified theory; indeed, it has proved troublesome even to find universally applicable laws. Many doubt that there are anywhere in biology laws of the kind so impressively found in physics and chemistry, but at least in organismic biology there are regularities and trends enough to build a science, and so molecular biology and genetics have developed into impressive sciences. But ecology has resisted grand theory and many of its leading ideas—such as succession, or climax species, or trophic levels, or the diversity-stability hypothesis, or capstone species, or carrying capacity, or feedback loops for stability, or fire ecology—have proved piecemeal and partial, hardly universal laws, only local generalizations that sometimes have exceptions.

Chaos has come into vogue in science, and there can almost be a science of chaos, where impressive regularities arise within chaotic processes. One does have to have dependable regularities enough to make a science of these, and in ecology many now think that these are hard to come by. Some ecologists insist that ecosystem histories are more random walks than they are stable dynamisms. Donald Worcester says, "Over the past two decades the field of ecology has pretty well demolished ... a world of ecosystems tending toward equilibrium, leaving us with no model of development for human society to emulate. ... Nature, we are now told, should be regarded as a landscape of patches of all sizes, textures, and colors, changing continually through time and space, responding to an unceasing barage of perturbations."[20] That doesn't sound like much stability. If not, on what basis is science to advocate sustainability?

Again, we are going to need to get the descriptions right to know what prescriptions to make. Ecosystems are dynamic systems involving both order and novelty. The stability of ecosystems is not a frozen sameness. Ecosystems undergo successions, periodically rejuvenated—disturbance, early, middle, and late succession, climax. But, depending on how frequent and extensive these interruptions are, succession can be more ideal than real. If often enough interrupted, ecosystems wander though contingencies as much as do they steadily develop. Both can be true. Ecosystems may be stable within bounds, within which they wander, but, when unusual disturbances come, with enough amplitude to knock them out of bounds, they are displaced beyond recovery of their former patterns. Then they wander until they settle into some new equilibrium.

The idea of an ecosystem being temporarily displaced from its equilibrium by some upset (a hurricane, a fire), to which equilibrium it soon returns, is only

a half truth. There other possible responses; the ecosystem may restructure after the upset; the upset may hasten historical trends that were already at work more slowly, or it may introduce new historical directions, if it permits some species to get established that would not otherwise have done so. There is not some one and only one stable state that an ecosystem should always have. Ecosystems are always on historical trajectory.

But ecosystemic stability is at least a half truth. Ecosystemic stability (like complexity, diversity, integrity, health) is both a general paradigm and a measurable characteristic at particular levels. Some ecosystems may be *constant,* that is, little changing in some dimensions. Temperatures change rather little in some tropical forests; species richness or evenness may remain about the same. Ecosystems may be *persistent,* that is, last long periods of time with little changes in species and their interrelationships. Ecosystems may have *inertia,* that is, resist external perturbations; this will probably be because of negative feedback loops that dampen changes.

Ecosystems may be *elastic;* if so, they return rapidly to their former state after pertubation. This may depend on *the amplitude* of the pertubation, both the area disturbed and the degree of displacement. Ecosystems sometimes have *cyclic stability,* that is, oscillate periodically about some central mean, or they may have *trajectory stability,* that is, move steadily along routes of succession or, more vector-like, have historical tendencies. A trajectory stability recognizes that some ecosystems may be steadily changing over time.[21] Ecosystems may be cycles on cycles at close hand but really, over longer times, spirals that stretch out directionally (like a stretched-out spring). Scientists can get numbers for some of these dimensions of stability.

Against the sheer random walk hypothesis, there is no doubt that ecosystems are full of cybernetic subsystems, species lineages that transmit information over time. Coded in the genetics and expressed in the coping behaviors of its member species, ecosystems will have the capacity to adjust to interruptions that come often enough to be remembered in the genetic memory. If climatic changes, or novel species invasions, are not too overwhelming, we expect that ecosystems that have long persisted will persist longer. Nothing succeeds like success.

Stability and historical change have to be scaled. The time frames of some ecological changes are the familiar cycles of spring, summer, winter, fall or rainy and dry season. Also, there are sometimes longer cycles. The burned forests of Yellowstone National Park are regenerating, but only our great grandchildren will see them back like they were a decade ago. On a big enough scale, ecology meets evolution. Or, perhaps we should say, the evolution going on all the time becomes evident. The cycles of ecology become the spirals of evolutionary history. So historical change is made possible by stability that supports variation.

Meanwhile, on the scale of deep time, some processes continue on and on, so that the perennial givens—wind and rain, soil and photosynthesis, life and death and life renewed—can seem, and indeed are, quite stable. Species survive for millions of years. The water cycles back, century after century. The farmer plants crops another season. Forests do regenerate, as Yellowstone will; it is already happening. The oxygen content of the atmosphere stays the same. There is a great deal of reliability in ecosystems, which we do want to sustain. There have been endless changes in evolutionary history; nevertheless there has been a sustainable biosphere for thousands of millions of years.

Human life is lived on the scale of ecology, long though these scales sometimes are. A human life is eight decades, more or less; those of our immediate experience include our grandparents, parents, children, grandchildren, covering a century and a half. On these scales there is considerable stability in nature, and we do not want to introduce cultural changes that the natural dynamism of ecosystems cannot absorb. Leopold uses the word "stability" in the time frame of land-use planning. On that scale, nature typically does have a reliable stability, and farmers, scientists, advocates, and everybody else ought to figure in these perennial givens.

Our national histories cover many centuries, during which we must be prepared for natural systems to change. Even national histories hardly reach the scale of major evolutionary changes (several thousand years), so scientists and advocates need not worry overmuch about stability at that scale. Meanwhile, we humans, in this century and in the next, very much threaten these long-standing natural processes that have yielded a sustainable biosphere for so many millennia. Why is it not a responsibility of scientists, as much as ethicists, to be concerned about these threats?

Earth ethics: sustaining and managing the planet

Facts and values have concerned philosophers and scientists for many centuries. The novelty and urgency in our century, and increasingly in the century ahead, is moving these issues to the global level. Thanks to both the Enlightenment and Western science, we humans today now know more about nature than did any previous generation of humans; we also have more power to affect natural forces at the global level than have humans ever before. Willy-nilly, we humans have to think of ourselves as planetary managers and sustainers. In earlier times, one might have preferred the words "dominion" or 'trustee," "overseer" or "steward," residual from the classical religious tradition. In our more secular epoch, the words that have come to replace these, are "sustainability" and "management." The Biblical vision of humans placed on Earth to have dominion over, to tend and to keep the garden Eden, no longer seems

quaint and prescientific. The old vision returns in a de-mythologized, post-modern form.

William Clark writes, in a *Scientific American* issue devoted to *Managing Planet Earth*, "We live in an era characterized by syndromes of global change. ... As we move from merely causing these syndromes to managing them consciously, two central questions must be asked? What kind of planet do we want? What kind of planet can we get?".[22] Adam and Eve were hardly so bold. Those questions do not preclude nonanthropocentric answers; but they strongly suggest that humans are being asked what they want out of the planet; and the planetary managers, assisted by their scientists, will figure out how to get it. The root of "manage" is the Latin "manus," hand. Humans will handle the place. This can even mean that *Homo sapiens* is the professional manager of an otherwise valueless world. Nature is to be harnessed to human needs.

This managing the planet begins to sound like the end of nature, the replacement of spontaneous nature with a new epoch of deliberate control, humanizing the Earth. Perhaps there looms before us what some call, rather dramatically, the end of nature"[23]). In the twenty-first century, there will only be nature that is managed, not spontaneous nature. Let's face the facts, the technocrat will insist. Humans now control 40% of the planet's land-based primary net photosynthetic productivity.[24] The World Bank found that 35% of the Earth's land has now become degraded.[25] Surely, our only option is to intervene more intelligently—to manage the planet

Well, yes, no one wishes to oppose intelligent management, and yet one does have to ask what kind of planet do we want, as Clark puts it. In an Earth ethics, ought humans to place themselves at the center of values, claiming management of the whole in their human self-interest? Placing one's own species at the center, a biologist may insist, is just what goes on in the woods; warblers take a warblo-centric point of view; spruce push only to make more spruce. Humans are unlikely not to act in their own intelligent and prudential self-interest

Other biologists will also insist, however, that the system takes no such particular points of view but generates myriads of such kinds. If they wish also to recall the classical religious vision, God bade the Earth to produce its swarms of creatures, and found this to be very good, even before God turned to make humans. Humans will no doubt have to manage the planet so as to meet their own needs, but there is more to be said. Humans are the only species who can see an ecosystem for what it objectively is, a community of interconnected species, each with a niche and a role to play, and integrated into a community of life. Conservation biologists can and ought to help humans save their life support system, Earth as our home planet. They also have a larger responsibility of showing how humans can and ought to take their place in the global community of life. Maybe that too is what is meant by dominion and keeping

the earth, or, in the more current vocabulary, something that the postmodern planetary managers ought to sustain.

Perhaps we can put it this way. In addition to saving fauna and flora, conservation biologists can and ought to save humans by daily rescuing them from falling into a beguiling anthropocentrism which is too human-centered, too proud. They can do this through helping humans to have perennial contact with the primeval biological and geomorphic givens. Conservation biology should liberate us from a narrow humanism and help us gain fuller humanity by transcending merely human interests. Biologists will be at their best when they can help to reform human character in encounters with a value-laden world.

Ethical conservatives, in the humanist sense, will say that the Earth and its biosphere is of value only because Earth contributes to human experiences. They will put humans at the center of concerns. That is the Enlightenment heritage, its vision becoming reality with the power of modern science. But that mistakes the last chapter, perhaps the climax, for the whole story, as though there were no concerns except those in center focus. Humans count enough to have the right to flourish here on Earth, but not so much that we have the right to transform the planet into nothing but our resource, not at least without a burden of proof that there is an overriding cultural gain. The ethical conservative in the ecological sense sees that the stability, integrity, and beauty of biotic communities on Earth is what is most fundamentally to be sustained, with human cultures in harmonious relationships with such life-supporting nature.

The planetary Earth system is, in fact, where the real ability to produce value arises. Value does not arise, as we in our anthropocentric arrogance might say, only when we humans arrive on the scene to assign and project our values there. Making the fallacy of misplaced values, this is as though a person were to dip water at a fountain of life, watering a lush land, then value the water and the fountain instrumentally, and comment that nothing was of value until I came. It is like finding a goose that lays golden eggs and valuing the eggs but not the goose.

We have on our hand the results of millennia of evolutionary natural history, some five to ten million species. In the Biblical vocabulary, these are the "swarms of creatures" that the Earth brought forth. That description of what has happened generates the conviction that the life story ought to continue, and this moves biology into ethics. True, this is not any ordinary logical deduction or scientific law from which one derives ethics. All we can do is tell the epic story—eucaryotes, trilobites, dinosaurs, primates, persons who are scientists, ethicists, conservation biologists, environmental advocates—and the drama, if true to life, may prove enough to justify it. There will be no inductive, deductive or other scientific inference to the conviction that we ought to respect life. But one would be unreasonable indeed to deny this.

Biologists here, scientists though they may be, cannot refuse to become philosophical, ethical, even religious. They find something sacred about life, in, with, and under the secular. The line between respect and reverence for life is crossed over, somewhere in the zone of the sublime. One of the world's most eminent biologists, Ernst Mayr, says: "Virtually all biologists are religious, in the deeper sense of the word, even though it may be a religion without revelation. ... The unknown and maybe unknowable instills in us a sense of humility and awe."[26] Such a thoughtful biologist is urged on to a sense of respect for nature. "And if one is a truly thinking biologist, one has a feeling of responsibility for nature, as reflected by much of the conservation movement".[27]

The chief threat that such creative processes face today is *Homo sapiens.* Indeed, this is the greatest threat that the speciating processes have faced in the history of the planet. So the "wise species" faces an enormous responsibility. Managing the otherwise valueless planet is not an apt paradigm, besides which all other conservation ideologies are backward romanticisms. Why not, for instance, think of ourselves as residents who are learning the logic of our home community, or as moral overseers trying to optimize both the cultural and the natural values on the planet? Is our only relationship to nature one of engineering it for the better? Perhaps what is as much to be managed is this earth-eating, managerial mentality that has caused the environmental crisis in the first place.

Humans cannot simply take nature ready to hand, but we must remake it for the supporting of agriculture, industry, culture. After that, perhaps, on the larger planetary scales, it is better to build our cultures in intelligent harmony with the way the world is already built, rather than take control and rebuild the planet by ourselves and for ourselves. "Hands" (the root of "manage", again) are also for holding in loving care. Scientists have as much responsibility for teaching us how to hold Earth in loving care as they do for giving us power for development

Earth is really the relevant survival unit, and, if so, we need an Earth ethics, above all else. From this viewpoint, we do not face the end of nature, replaced by culture. Sustainable development can be a good thing; without it there will be increased suffering in the future. Of that there is little doubt. But if we ask about our children and grandchildren, the potential threats that they face are many; the one most likely to become real is a degraded natural environment

Vital conservation biology

The fundamental reason that ethics is entwined with biological science is that biology places because it finds values at the core of life. Biology can mean two things: Biology is the scientific study that is undertaken by humans; this takes

place on field trips and in laboratories, is written up in journals and books, and taught to students. But biology is also what goes on out there in nature. That biology does not go on in human minds; it went on in the days of the dinosaurs and continues today. Earth is the planet remarkable for its biology, the only biosphere we know in the universe.

The logic of life in both kinds of biology, the bio-logic, is conservation biology. Conservation biology was not invented by human scientists who became environmentalist advocates. Conservation biology began billions of years ago, for the essential genius of life is its conservation, life preserved in the midst of its perpetual perishing. Something has to be, and has been, conserved across evolutionary natural history in ways radically different *from* any conservation in physics or chemistry. A genetic set is a set of conservation molecules. An organism can survive only so far as it has structures, behaviors, metabolisms, skills that have survival value, coded in its genes and used for coping in life. Biology without conservation is death and extinction. So values are integral to the logic of biology.

In biology much is vital, and vital is a value word as readily as it is a metabolic word. There is a long-standing ethical tradition of respect for life; the difference in ecology is that the focus moves to life at the more comprehensive levels of the ecosystem, and to the protection of the diversity that is the heritage of evolutionary natural history. Humans have arrived on this world scene quite lately, and only more lately still have humane come to jeopardize this panorama of flourishing life. In the face of such jeopardy, humans, both biologists and ethicists, come to value life and to find its conservation imperative. Humans are the creatures with a conscience; we ought to value human life and wild life. A biologist who does not respect life is just as much a contradiction in terms as is an ethicist who does not. That joins forever environmental science and environmental ethics.

Notes

1. Schiff, 1962; Lee, 1991.
2. Lubchenco et al, 1991.
3. Risser, Lubchenco, Levin, 1991.
4. Risser, Lubchenco, Levin, 1991.
5. Risser, Lubchenco, Levin, 1991.
6. World Commission, 1987, p. 43.
7. Lubchenco et al, 1991, p. 374.
8. Risser, Lubchenco, Levin, 1991.
9. Craig, 1992b.
10. Craig, 1992b.
11. Craig, 1992a.
12. Craig, 1992a.

13. SAP, 1992.
14. Lee, 1991.
15. Leopold, 1968, p. 221.
16. Karr, Dudley, 1981.
17. Costanza et al., 1992, p. 9.
18. Leopold, 1968, p. 221.
19. Leopold, 1968, pp. 224-225.
20. Worster, 1994.
21. Orians, 1975.
22. Clark, 1989.
23. McKibben, 1989.
24. Vitousek et al., 1986.
25. Goodland, 1992.
26. Mayr,1982, p.81.
27. Mayr, 1985, p. 60.

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