David W. Ehrenfeld

The Conservation of Non-Resources

Conservation cannot rely solely on economic and ecological justifications. There is a more reliable criterion of the value of species and communities

Conservation is usually identified with the preservation of natural resources, and this was certainly the meaning intended by the person who probably coined the word, Gifford Pinchot. Resources can be defined very narrowly as reserves of commodities that have an appreciable money value to man, either directly or indirectly. Since the time that Pinchot first used the word, it has been seriously overworked. A steadily increasing percentage of "conservationists" has been preoccupied with preservation of natural features—species, communities, and ecosystems—that are not conventional resources.

An example of such a non-resource is an endangered amphibian species, the Houston toad, *Bufo houstonensis* (*1*). This animal (Fig. 1) has no demonstrated or conjectural resource value to man, other races of toad will replace it, and its passing is not expected to make an impression on the *Umwelt* of the city of Houston or its suburbs. Yet someone thought enough of the Houston toad to give it a page in the International Union for the Conservation of Nature's lists of endangered animals and plants (*2*), and its safety has been advanced as a reason for preventing oil drilling in a Houston public park (*3*).

The Houston toad has not claimed the undivided attention of conservationists, or they might by now have discovered some hitherto unsuspected value inherent in it; and this is precisely the problem. Species and communities that lack an economic value or demonstrated potential value as natural resources are not easily protected in societies that have a strongly exploitative relationship with nature. Many communities, probably the majority of plant and animal species, and some domesticated strains of crop plants fall in this category, at or near the non-resource end of a utility continuum. Those in favor of their preservation are often motivated by a deeply conservative distrust of irreversible change and/or a socially atypical attitude of respect for the components and structure of the natural world. These attitudes are not acceptable as a basis for conservation in Western-type societies, except in those few cases where preservation costs are minimal and there are no competing uses for the space now occupied by the non-resource. Consequently, defenders of non-resources generally have attempted to secure protection for their "useless" species or environments by means of a change of designation: a "value" is discovered, and the non-resource metamorphoses into a resource.

Perhaps the first to recognize this process was Aldo Leopold (*4*), who wrote in "The Land Ethic" that "one basic weakness in a conservation system based wholly on economic motives is that most members of the land community have no economic value.... When one of these non-economic categories is threatened, and if we happen to love it, we invent subterfuges to give it economic importance."

Economic value of non-resources

The values attributed to non-resources are diverse and sometimes rather contrived, hence the difficulty of trying to condense them into a list. In my efforts I have relied, in part, on the thoughtful analyses provided by several members of the Nature Conservancy (*5*). All values listed below can be assigned a monetary value and thus become commensurable with ordinary goods and services—although in some cases it would require a good deal of ingenuity to do this. All are anthropocentric values.

1. *Recreational and esthetic values.* This is one of the most popular ways of assigning value to non-resources, because although frequently quite legitimate, it is also easily fudged. Consequently, it plays an important part in cost-benefit analyses and impact statements, filling in the slack according to need. The category includes items that involve little interaction between man and environment: scenic views can be given a cash value. Less remote interactions are hiking, camping, sport hunting, and the like. Organizations such as the Sierra Club stress many of these qualities, in part because their membership values them highly. It is no coincidence, for example, that among the Australian mammals, the large, showy, beautiful, diurnal ones, those that might be seen on safari, are zealously protected by conservation-

David W. Ehrenfeld received his B.A. in history from Harvard College, his M.D. from Harvard Medical School, and his Ph.D. in zoology and biochemistry from the University of Florida. Dr. Ehrenfeld has taught at Florida and at Barnard College, Columbia University, and is now Professor of Biology at Cook College, Rutgers University, and a member of the Rutgers graduate training programs in ecology and zoology. His research is on the behavior, physiology, and conservation of sea turtles. He is an associate editor of the journal Human Ecology *and the author of two books on conservation ecology, the most recent being* Conserving Life on Earth *(NY: Oxford Univ. Press, 1972).* *The author thanks Ian Baldwin, William Goldfarb, Harold Hayes, James Raimes, and, especially, Joan Ehrenfeld for their criticism and suggestions. Parts of this paper were presented in April 1976 at the annual meeting of the Association of American Geographers in New York.* *Address: Cook College, Rutgers University, P.O. Box 231, New Brunswick, NJ 08903.*

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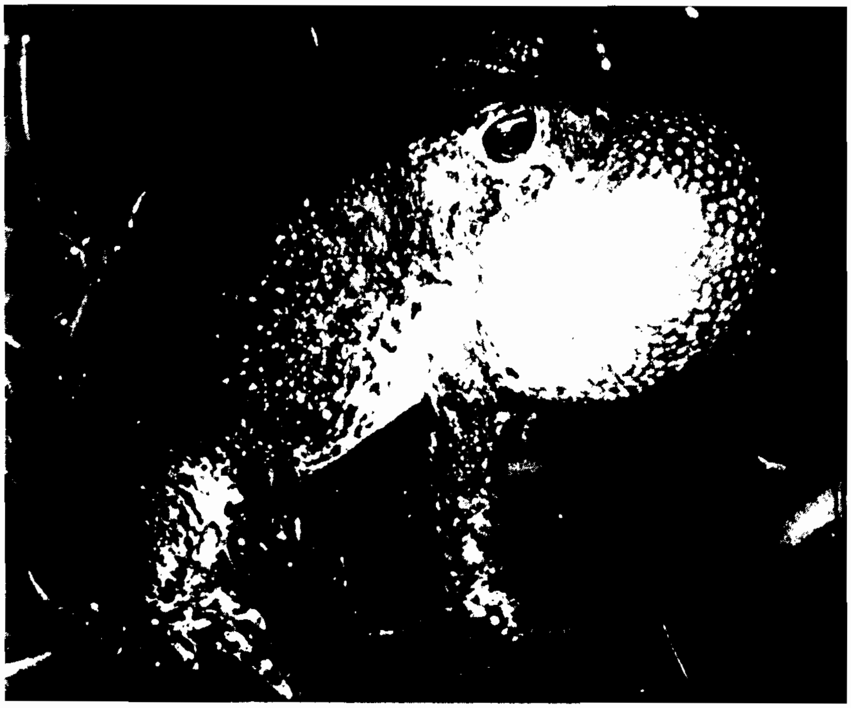

Figure 1. In perhaps the only photograph of a live Houston toad, *Bufo houstonensis*, this male toad was calling at Barking Dog Pond, Bastrop County, Texas, 1966. The quintessential non-resource, this drab and ordinary-looking species of bufonid has no economic value of any kind. Photograph by M. J. Littlejohn, University of Melbourne, Parkville, Australia; courtesy of Dr. Lauren E. Brown, Illinois State University, Normal, Illinois.

ists and are mostly doing well, while the small, inconspicuous, nocturnal marsupials include a distressingly large number of seriously endangered or recently exterminated species (*6*).

Some of the most determined attempts to place this recreational and esthetic category on a firm resource footing have been made by those who claim that the opportunity to enjoy nature, at least on occasion, is a prerequisite for sound mental and physical health. Several groups of long-term mental patients have supposedly benefited more from camping trips than from other treatments, and physiologically desirable effects have been claimed for the color green and for environments that lack the monotony of man-organized space (*7*).

2. *Undiscovered or undeveloped values.* In 1975 it was reported that the oil of the jojoba bean, *Simmondsia californica*, is very similar to oil of the threatened sperm whale in the stability of its responses to high temperatures and pressures. Overnight, this desert shrub of the American Southwest was converted from the status of a minor to a major resource (*8*). It can safely be assumed that many other species of hitherto obscure plants and animals have great potential value as bona fide resources once this potential is discovered or developed. Plants are probably the most numerous members of this category: in addition to their possibilities as future food sources, they can also supply structural materials, fiber, and chemicals for industry and medicine (*9*).

Animals have potential resource uses that parallel those of plants, but this potential is being developed at an even slower rate. The potential for domestication and large-scale production of the vicuña, the source of one of the finest animal fibers in the world, was only recognized after its commercial extinction in the wild had become imminent.

Some species are potential resources indirectly, by virtue of their ecological associations. Galston (*10*) has described one such case involving the water fern, *Azolla pinnata*, which has long been cultivated in paddies along with rice by peasants in northern Vietnam. This inedible and seemingly useless plant harbors colonies of nitrogen-fixing blue-green algae in pockets on its leaves. Not surprisingly, villages that have been privy to the secrets of fern cultivation have tended to produce exceptional quantities of rice.

Species whose resource possibilities are unknown cannot, of course, be singled out for protection, but most or all communities are likely to contain such species. Thus the undeveloped resource argument has been used to support the growing movement to save "representative," self-maintaining ecosystems in all parts of the world. Such ecosystems range from the stony and comparatively arid hills of Galilee, which still shelter the wild ancestors of wheat, oats, and barley, to the tropical forests of the world, whose timber, food, and forest product resources remain largely unknown even as they are destroyed (*11*).

3. *Ecosystem stabilization values.* This item is at the heart of the complex controversy that has arisen over the ecological theory of conservation. In its general form, Commoner (*12*) has stated it clearly:

> The amount of stress which an ecosystem can absorb before it is driven to collapse is also a result of its various interconnections and their relative speeds of response. The more complex the ecosystem, the more successfully it can resist a stress.... Like a net, in which each knot is connected to others by several strands, such a fabric can resist collapse better than a simple, unbranched circle of threads—which if cut anywhere breaks down as a whole. Environmental pollution is often a sign that ecological links have been cut and that the ecosystem has been artificially simplified.

A more general, less controversial formulation of this "diversity-stability" concept is discussed separately under item 9.

One fairly specific (and less troublesome) derivation of the diversity-stability hypothesis concerns monocultures in agriculture and forestry. It has long been known that the intensive monoculture that characterizes modern farms and planted forests generates greater ease and reduced costs of cultivation and harvesting, and increased crop yields; but this is at the expense of higher risk of epidemic disease and vulnerability to insect and other pest attack (*13*). Here a reduction of species diversity results in much closer spacing of similar crop plants, which in turn facilitates the spread of both pests and disease organisms. It also eliminates plant species that constitute shelter for natural enemies of the specialized plant pests. Monocultures also create problems in ranching and fish farming, often because of incomplete use of available food resources by the single species involved.

4. *Examples of survival.* Communities and, to a lesser extent, species can have a value as examples or models of long-term survival. Humke et al. (*5*) observed that "most natural systems have been working in essentially their present form for many thousands of years. On the other hand, greatly modified, man-dominated systems have not worked very reliably in the past and, in significant respects, do not do so at present." The economic value here is indirect, consisting of problems averted (money saved) by virtue of good initial design of man-dominated systems or repair of faulty ones, based on features abstracted from natural systems. This viewpoint is becoming increasingly popular as disillusionment with the results of traditional planning grows. Thus it may make sense to look to successful natural communities for clues concerning the organization of traits leading to persistence or survival. Wright (*14*) has stated this non-resource value in its strongest form in the final sentence of an interesting article on landscape development: "The survival of man may depend on what can be learned from the study of extensive natural ecosystems."

5. *Environmental baseline and monitoring values.* The fluctuation of animal or plant population sizes, the status of their organs or by-products, or even the mere presence or absence of a given species or group of species in a particular environment can be used to define normal or baseline environmental conditions and to determine the degree to which communities have been affected by extraordinary outside influences such as pollution or man-made habitat alteration. Biological functions such as species diversity (in the full sense of the term, which includes both richness and equitability measurements) are the best possible indicators of the meaningful effects of pollution, just as behavior is the best single indicator of the health of the nervous and musculoskeletal systems. Species diversity is a final common path, a resultant of all forces that impinge on ecosystems. It should also be noted that the traditional economic value of a species is of no significance in determining its usefulness as an environmental indicator—an important point if we are concerned with the metamorphosis of non-resources into resources.

With the exception of the biological monitoring of water pollution, this branch of conservation ecology is still in its infancy. In the case of water pollution, much of the pioneering work on algal and invertebrate communities has been done by Ruth Patrick and her associates (*15*). Lichens are sensitive indicators of air pollution, especially that caused by dust and sulfur dioxide (*16*). The common lilac, *Syringa vulgaris*, develops a disease called leaf roll necrosis in response to elevated levels of ozone and sulfur dioxide. The honey of honeybees can be used to monitor environmental heavy metal pollution (*17*). Organ analyses of snakes have been recommended as a way of following organochlorine pesticide and PCB residues in terrestrial environments (*18*). The presence of kinked or bent tails in tadpoles may be an indicator of both pesticides and local climatic change (*19*).

6. *Scientific research values.* Many creatures that are otherwise economically negligible have some unique or special characteristic that makes them extremely valuable to research scientists. Because of their relationship to man, orangutans, chimpanzees, and even the lower prosimians fall in this category. Squids and the sea hare, *Aplysia*, have nervous system properties that make them immensely valuable to neuroscientists. The identical quadruplet births of armadillos and the hormonal responses of the clawed toad, *Xenopus*, make them objects of special study to embryologists and endocrinologists, respectively. The odd life cycle of slime molds has endeared these fungi to biologists studying the chemistry of cell-cell interactions.

7. *Teaching values.* The teaching value of an intact ecosystem may be quantified by noting the economic value of displaced land-use alternatives. For example, a university administration may preserve a teaching forest if the competing use is as an extra parking lot for maintenance equipment, but it may not be so inclined toward conservation if the land is wanted for university housing.

In one case, in 1971, a U.S. Federal District Judge ordered the New York State National Guard to remove a landfill from the edge of the Hudson River and restore the brackish marsh that had occupied the site previously. One of the reasons he cited, although not the most important one, was the marsh's prior use by local high school biology classes (*20*).

8. *Habitat reconstruction values.* If we wish to restore or rebuild an ecosystem in what was once its habitat, we need a living, unharmed ecosystem of that type to serve as both a working model and a source of living components. This is tacitly assumed by tropical forest ecologists, for example, who realize that clear-cutting of very large areas of tropical moist forests is likely to be incompatible with maintaining a sustained yield of the full diversity of tropical hardwoods. In some north temperate forests, strip-cutting, with intervening strips of forest left intact for reseeding and animal habitat, is now gaining favor in commercial timber operations. Actual cases of totally rebuilt ecosystems are still rare: the best example may be the salt marsh reconstructions by Garbisch and his coworkers (*21*). If certain future endangered ecosystems are recognized as useful to man, then any remnant patches of these ecosystems will assume a special resource value.

9. *Conservative value: Avoidance of irreversible change.* This is a general restatement of a basic fear underlying every other item on this list; sooner or later it turns up in all discussions about saving non-resources. It expresses the conservative belief that man-made, irreversible change in the natural order—the loss of an evolved gene pool or community—may carry a hidden and unknowable risk of serious damage to humans and their civilizations. Preserve the full range of natural diversity because we do not know the aspects of that diversity upon which our long-term survival depends. This was Aldo Leopold's basic argument (*4*): "A system of conservation based solely on economic self-interest is hopelessly lopsided. It tends to ignore, and thus eventually to eliminate, many ele-

ments in the land community that lack commercial value, but that are (as far as we know) essential to its healthy functioning."

Without in any way impugning the truth of this statement, two serious oversights or omissions might be pointed out in Leopold's argument. First, Leopold provides no real justification for preserving those animals, plants, and habitats that are almost certainly not essential to the "healthy functioning" of any large ecosystem. This is not a trivial category, and includes, in part, the great many species and even communities that have always been extremely rare or that have always had very restricted distributions. Second, although Leopold rejected "economic self-interest" as a sole motive for conservation, he evidently did not realize that preserving the "healthy functioning" of land communities is also an economic self-interest argument, albeit one that manifests its resource benefits indirectly and over the long term.

Exaggerations and distortions

In surveying the preceding list of reasons for valuing and hence preserving non-resources, the most striking feature is its practical political weakness. Regardless of the truth of these explanations of value, they are not as convincing as those that are backed by a promise of short-term economic gain. In a capitalist society, any private individual or corporation that treats non-resources as if they were resources is likely to go bankrupt. In a socialist society, the result will be nonfulfillment of growth quotas. People do not seem ready to assign resource values on the basis of long-term considerations or mere statistical probabilities of danger. As Matthews has pointed out (*22*), even "human health, especially in areas outside of cancer (for example, [sickness] from asbestos) and massive deaths (for example, from nuclear reactor accidents), is often given a second priority to the economic criteria [of GNP, employment, and the standard of living]."

If we examine the "conservative value" of non-resources discussed above, the difficulty immediately becomes plain. The economic value in this case is a remote and nebulous one: it is protection from the unknown dangers of irreversible change. An added problem is that if a danger materializes, it may be too late to reverse policy or it may be impossible to prove a connection with the initial loss of the non-resource. Even in those cases where loss of a non-resource seems likely to initiate long-term undesirable change, the argument may be too complex and technical to be widely persuasive among non-scientists or it may be contrary to popular belief. An excellent example has been provided by Owen (*13*) and by Ormerod (*29*) who have claimed that the tsetse fly, dread vector of African trypanosomiasis, may be essential to the well-being of large parts of sub-Saharan Africa.

In summary, the usual reasons that are advanced to persuade people to accept non-resources as resources are not very likely to convince them, regardless of their truth. When everything is called a resource, the word loses all meaning—at least in our value system.

One consequence of the failure to persuade is that conservationists are provoked into exaggerating and distorting the alleged values of non-resources. The most vexing and embarrassing example for conservationists concerns the diversity-stability issue. It is important to make clear at the outset that the necessity of maintaining diversity is not questioned. As one critical ecologist put it (*23*), "From a practical standpoint, the diversity-stability hypothesis is not really necessary; even if the hypothesis is completely false it remains logically possible—and, on the best available evidence, very likely—that the disruption of the patterns of evolved interaction in natural communities will have untoward, and occasionally catastrophic consequences."

The first comprehensive statement of the diversity-stability hypothesis was made by Margalef (*24*). In a classic paper he claimed that the successional drive toward a "climax" community ("mature" ecosystem in his terminology), which is characteristic of all natural ecosystems, is one of several strong pieces of evidence that the late stages of succession are more "stable" than earlier ones. These late ecosystems were also thought to be more diverse, and using information theory Margalef claimed to have demonstrated that the higher information content and greater number of interactions is responsible for the increased stability. This was widely interpreted to mean that mature ecosystems were better able to buffer their environments, were more resistant to man-made perturbations (such as chemical pollution), than were earlier and simpler stages. From this were derived analogies such as the one quoted above from Commoner, in which the strength of a late successional community was compared with that of a net. There is much intuitive support for this hypothesis. As Goodman has said (*23*), there is a "basic appeal of its underlying metaphor. It is the sort of thing that people like, and want, to believe."

Even as Margalef was refining his hypothesis, four lines of investigation and evidence were combining to undermine part of it. First, the results of many separate studies of terrestrial and aquatic ecosystems showed that diversity does not always increase with succession, particularly in the final phases. Second, investigations of plant associations by Whittaker and his colleagues (*25*) tended to show that the interdependence and interactions of the species found in mature communities had been exaggerated—at least if one looked at a single trophic level. Third, the mathematical analysis of May (*26*) failed to confirm the intuitively attractive notion stated by Commoner that the greater the number of interactions, or links, the greater the stability of the system. May's models worked the other way: the more elements (species and species interrelationships) there were, the greater the fluctuation of the populations in the system when a simulated external perturbation was applied. In theory, the most complex systems were therefore at the greatest risk of collapse. Fourth, the direct evidence of conservationists and ecologists was against the hypothesis: the diverse, mature communities were almost always the first to fall apart under heavy, man-imposed stress and were always the most difficult to protect (at least in the case of terrestrial systems). Indeed, Margalef's own description of early colonizing species (Hutchinson's "fugitive species") indicated that these immature community residents were usually resilient, opportunistic, genotypically and phenotypically plastic, and behaviorally adaptable, and had high reproductive rates. They are the vermin, weeds, and common game species, among others, and very few of them are exclusive residents of climax communities (*27*).

As May and others had perceived, the diversity-stability hypothesis, in the restricted sense described here, was a case of inverted cause and effect. The most diverse communities were those that had occupied the most stable environments for the longest period of time: they were dependent on stability—not the reverse.

The most comprehensive and lucid review of the diversity-stability controversy has been written by Goodman (*23*). Although Goodman may place too much emphasis on population fluctuation and not enough on persistence as a measure of stability (*28*), it does not alter the moral of the story for conservationists. In our eagerness to demonstrate a present "value" for the magnificent, mature, and most diverse ecosystems of the world—the tropical rain and cloud forests, the coral reefs, the temperate zone deserts, etc.—we stressed the role they were playing in immediate stabilization of their environments (including their own component populations). This was a partial distortion that not only caused less attention to be paid to the real, long-term values of these ecosystems but also helped to obscure, for a while, their extreme fragility in the face of human "progress."

Many different kinds of stability are indeed dependent on biological diversity. This is especially evident today in those places, often tropical, where soils are prone to erosion, nutrient loss, or laterite crust formation, and where desertification can occur (*29*); but none of these effects, however deadly and durable, is ever likely to be as easy to explain to laymen as the "stable net" hypothesis.

A much less complex example of an exaggeration or distortion that has resulted from the impulse to find values for non-resources concerns African game ranching. In the 1950s and 1960s it was first pointed out that harvesting the wild animals of the bush and savanna might produce at least as much meat per acre as cattle raising, without the reduction in carrying capacity that traditionally has been associated with cattle in Africa (*30*). This suggestion cannot be faulted in ecological theory, which recognizes that the phenomenon of niche specialization enables the dozens of species of native, large herbivores to utilize the primary productivity much more efficiently and completely than cattle alone.

The pitfalls in this straightforward plan have only recently made themselves felt. Apart from serious cultural problems, the major drawback is ecological. The early game ranching theory and the subsequent cropping programs of Parker tacitly assume that the animals to be cropped will replace themselves, or, to put it another way, that the populations of edible, wild herbivores will be able to adapt to a heavy, annual loss to market hunters. This is no doubt true of some of the r-selected species, but not all are likely to be r-selected. Hippopotamus and elephant supposedly have been cropped successfully in several places; nevertheless, the population dynamics and management ecology of nearly all species are still largely unknown (*31*), and exploitation, illegal and legal, is proceeding with little more than speculation about the long-term consequences. The issue here is the danger of assuming, with an air of infallibility, that one knows what the ecological effects of cropping will be. This point has been made repeatedly by Hugh Lamprey and others most knowledgeable about east African ecology, and is beautifully illustrated in an anecdote told by John Owen, the noted former park director at Serengeti (*32*). Owen was describing the controversy over the return of elephants, 2000 strong, to Serengeti and the alleged damage they were doing to the park ecosystem:

> When I would come down from Arusha the wardens would take me around and show me the trampled acacias. Next day the scientists [from the Serengeti Research Institute] would take me out and show me the new acacia shoots blooming in another part of the park. Acacia seeds are carried and fertilized by elephant dung.

At this time, much of the trouble is with poachers, and there is admittedly the remote possibility that supervised game ranches and cropping schemes on a large scale will have the effect of making poaching (for cash sale) uneconomical. But there is also the possibility that game ranching and cropping will affect species diversity and ecosystem stability as much as poaching or even, in some cases, cattle raising. In our haste to preserve zebra, wildebeest, dik dik, and springbok by endowing them with a tangible economic value, we may have exaggerated one type of resource potential (they have many others) and in the process endangered them further.

One of the lessons of the examples cited above is that conservationists should not assume that ecological theory will always support their cases, especially when these cases concern specific, immediate objectives and when the scope of the debate has been artificially restricted by a short-term, cost-benefit type of approach.

Another example of a situation where ecological theories, if viewed in a restricted context, do not support conservation practices was described by Janzen (*33*):

> One possible remedy [for the year-round persistence of agricultural pests and diseases in the tropics] is unpleasant for the conservationist. The agricultural potential of many parts of the seasonally dry tropics might well be improved by systematic destruction of the riparian and other vegetation that is often left for livestock shade, erosion control, and conservation. It might be well to replace the spreading banyan tree with a shed.... Some studies even suggest that "overgrazed" pastures may have a higher overall yield than more carefully managed sites, ... especially if the real costs of management are charged against the system.

What is important here is that Janzen has demonstrated that it is quite possible for ecological theory to endow non-resources with a negative value, to make them out to be economic liabilities. In this particular case, long-term ecological considerations (such as the ultimate costs of erosion, nutrient dumping, and factors related to all the other items on the list given above) would probably militate against the short-term ecological considerations described by Janzen. But the practical net result of any conservationist's attempt to demonstrate a resource value for natural riparian and other vegetation in the seasonally dry tropics, based on ecological theory, would be to expose the conservation position to unnecessary attack.

The point being made here is easy to misinterpret. At the risk of seeming obvious, I must make clear that the purpose of this paper is a restricted one; it is to identify the honest and durable reasons for saving non-resources. This does not mean that I reject resource arguments when they are valid. The Amazonian rain forest, the green turtle, and many other forms of life contribute heavily to the maintenance of human well-being. The prospect of their loss is frightening to anyone with ecological knowledge, and it is not my aim to make it appear less so. But this is only one of the rationales for conservation, and it should not be applied carelessly, if for no other reason than the likelihood of undermining its own effectiveness.

Additional risks

Even when it is quite legitimate to find economic values for quondam non-resources, it may be risky, from a conservation viewpoint, to do so. Gosselink et al. (*34*) have conducted an elegant and painstaking investigation of the value of tidal marshes along the coast of the southeastern United States which can serve as an illustration of these risks.

The purpose of the project was to establish a definite monetary value for tidal marsh based on tangible resource properties. Esthetic values were therefore not considered. The properties studied included the function of tidal marshes in removing pollutants from coastal waters (tertiary sewage treatment), sport and food fish production, potential for commercial aquaculture, and an assortment of other less quantifiable functions. The income-capitalized value of intact marsh, computed on the basis of its energy flow, amounted to $82,940 per acre. Although the validity of the energy/money conversion might conceivably be challenged, it is unlikely that more laborious methods of estimating value, if they were sufficiently inclusive, would change the results significantly. Salt marshes are valuable.

Is calling attention to this value the best way to conserve salt marshes? If a given marsh were worth less if put to competing use than in its intact condition, the answer might be yes, provided that the marsh were publicly owned. But discovering value can be dangerous. First, any competing use with a higher value, no matter how slight the differential, would be entitled to priority in the use of the marsh site. Because most competing uses are for all intents and purposes irreversible, future change in relative usage values subsequent to the alteration of the marsh would have no effect, even if a marsh usage later were able to claim higher value and priority. We do not generally tear down luxury, high-rise apartments.

Second, values change. If, for example, a new process is discovered and tertiary treatment of sewage becomes suddenly less expensive (or if the sewage acquires value as a raw material), then that component of the marsh value will decline proportionally.

Third, the implication of the study is that both the valuable and diseconomic qualities of the salt marsh are all known and identified. Conversely, this means that those qualities of the salt marsh that have not been assigned a conventional value are not very important. This is a dangerous implication.

Fourth, Clark (*35*) has shown that quick profits from immediate exploitation, even to the point of extinction, often are economically superior to long-term, sustained yield gains of the sort generated by intact marsh, provided that the profits and the discount rate are each sufficiently high.

Given these four objections, the hazards of even legitimate reassignment of non-resources as resources become quite plain, as do the hazards of overemphasizing the cost-benefit approach in conserving more traditional resources.

Formal priority rankings

Another consequence of assigning resource value to non-resources deserves separate consideration: when real values are computed, it becomes possible to rank endangered ecosystems, or even species, for the purposes of assigning conservation priority. Because dollar values of the sort worked out for tidal marshes are generally not available, other ranking methods have been devised. These are meant to be applied in a mechanical, objective fashion.

Ranking systems based in large part on vegetation type have been devised for use in Wisconsin by Tans (*36*) and in Texas by Gehlbach (*37*). Properties that are scored and totaled in Gehlbach's system include "climax condition," "educational suitability," "species significance" (presence of rare, relict, peripheral, endemic, or endangered species), "community representation" (number and type of communities included), and "human impact" (current and potential), in order of increasing importance. Gehlbach evidently believes that the numerical scores generated by this system can be used, without additional human input, to determine conservation policy. He states that "it is suggested that if offered for donation [to the State of Texas], an area be accepted only when its natural area score exceeds the average scores of the same or similar community-type(s) in the natural area reserve system." Other ranking systems for both species and, more commonly, natural areas either exist in the literature or could be developed along the lines of the methods described above.

There are two fundamental problems with ranking systems that militate against their uncritical or mechanical use. First, there is the problem of incomplete knowledge. It is impossible to survey all the properties of any natural area (or species), and the dangers of overlooking value (positive or negative) are very great. Community descriptions, especially short ones, are largely artificial abstractions; they are designed to facilitate talking about vegetation, not deciding what to do with it. It is presumptuous to assume that any formal system of ranking can serve as a substitute for personal acquaintance with the land or informed human intuition about its meaning or value in the world of today or 100 years from now.

Second, formal ranking sets natural area against natural area in an unacceptable and totally unnecessary way. The need to conserve a particular community or species must be judged independently of the need to conserve anything else. Limited resources may force us to make choices against our wills, but ranking systems encourage and rationalize the making of choices. Ranking systems can be useful to conservationists as an adjunct to decision making, but the more formal and generalized they become, the more damage they are likely to cause.

There is only one account in Western culture of a conservation effort greater than that now taking place; it concerned endangered species. Not a single species was excluded on the basis of low priority, and by all accounts not a single species was lost. ("Of clean beasts, and of beasts that are not clean, and of fowls, and of everything that creepeth upon the earth, There went in two and two unto Noah into the ark, the male and the female, as God had commanded Noah" *Genesis* 7:8,9.) It is an excellent precedent.

Non-economic values

When one is confronted with a "double bind" that resists attempts at solution, the only rational approach short of surrender is to alter both one's viewing perspective and the general statement of the problem until the double bind disappears (*38*). The attempt to preserve non-resources by finding economic value for them generates a double bind. Much of the value discovered for non-resources is indirect in the sense that it consists of avoiding costly problems that might otherwise appear if the non-resources were lost. On the one hand, if the non-resource is destroyed and no ecological disasters ensue, then the conservation argument loses all capacity to inspire credence. On the other hand, if disaster does follow extinction of a supposed non-resource, then it will usually be too late to do anything about it, and it may well prove impossible to prove a causal relationship between the initial loss of the non-resource and the subsequent disaster. Indeed, no one may even think of the connection.

A way to avoid the non-resource double bind is simply to identify the *non*-economic values inherent in all natural communities and species and to weight them at least equally with resource values. The first of these universal qualities might be described as the "natural art value." It has been best articulated by Carr (*39*):

> It would be cause for world fury if the Egyptians should quarry the pyramids, or the French should loose urchins to throw stones in the Louvre. It would be the same if the Americans dammed the Valley of the Colorado. A reverence for original landscape is one of the humanities. It was the first humanity. Reckoned in terms of human nerves and juices, there is no difference in the value of a work of art and a work of nature. There is this difference, though. . . . Any art might somehow, some day be replaced—the full symphony of the savanna landscape never.

This viewpoint is not common but is apparently gaining in popularity. In an article on Brazil's endangered lion tamarins or marmosets, three species of colorful, tiny primates of the Atlantic rain forests, Coimbra-Filho et al. advanced the notion of natural art in a frank and thoughtful statement remarkably similar to the preceding quotation (*40*):

> In purely economic terms, it really doesn't matter if three Brazilian monkeys vanish into extinction. Although they can be (and previously were) used as laboratory animals in biomedical research, other far more abundant species from other parts of South America serve equally well or better in laboratories. Lion tamarins can be effectively exhibited in zoos, but it is doubtful that the majority of zoo-goers would miss them. No, it seems that the main reason for trying to save them and other animals like them is that the disappearance of any species represents a great esthetic loss for the entire world. It can perhaps be compared to the destruction of a great work of art by a famous painter or sculptor, except that, unlike a man-made work of art, the evolution of a single species is a process that takes many millions of years and can never again be duplicated.

It should be noted that this natural art, unlike man-made art, has no economic worth, either directly or indirectly. No one can buy or sell it for its artistic quality, it does not always stimulate tourism, nor does ignoring it cause, for that reason, any loss of goods or services. It is distinct from the recreational and esthetic resource value described earlier and may apply to communities and species that no tourist would detour a single mile to see or to qualities that are never revealed to casual inspection.

Free as it is of some of the problems associated with resource arguments, the natural art rationale for conservation is nevertheless, in its own way, a bit contrived, and a little bit confusing. Do all ecological associations have equal artistic value? Most critics would say that El Greco was a greater painter than Stubbs, but is the African savanna artistically more valuable than the New Jersey Pine Barrens?

Even if we concede that the art rationale for conservation does not foster the kind of comparisons that are the essence of traditional art criticism, there is still something wrong: the natural art concept is still rooted in the same homocentric, humanistic world view that is responsible for bringing the natural world, including us, to its present condition. If the natural world is to be conserved because it is artistically stimulating to man, there is still a condescension and superiority implied in the attitude of man, the kindly parent, toward nature, the beautiful problem-child. This attitude is not in accord with humility-inspiring discoveries of community ecology or with the sort of ecological world view, emphasizing the connectedness and immense complexity of the man-nature relationships, that now characterizes a large bloc of conservationist thought (*41*). Nor is it in accord with the growing bloc of essentially religious sentiment that approaches the same position of equality in the man-nature relationship from a nonscientific direction.

The exponents of natural art have done conservation a great service, being the first to point out the unsatisfactory nature of some of the economic reasons advanced to support conservation. But something else is needed. Elton (*42*) has indicated another non-resource value, the ultimate reason for conservation and the only one that cannot be compromised:

> The first [reason for conservation], which is not usually put first, is really religious. There are some millions of people in the world who think that animals have a right to exist and be left alone, or at any rate that they should not be persecuted or made extinct as species. Some people will believe this even when it is quite dangerous to themselves.

This non-economic value of communities and species is the simplest of all to state: they should be conserved because they exist and have existed for a long time. Long-standing existence in nature is deemed to carry with it the unimpeachable right to continued existence. Existence is the only criterion of value, and diminution of the number of existing things is the best measure of decrease of value. This is, as mentioned, an ancient way of evaluating "conservability," and by rights ought to be named the "Noah Principle" after the person who was one of the first to put it into practice.

Currently, the idea of rights conferred by other-than-human existence is becoming increasingly popular (and is meeting with increased resistance). I shall give only two examples. In a book entitled *Should Trees Have Standing?* Stone has presented the case for existence of legal rights of forests, rivers, etc. apart from the vested interests of people associated with these natural entities. Describing the earth as "one organism, of which Mankind is a functional part," Stone extends Leopold's land ethic in a formal way, justifying such unusual lawsuits as *Byram River, et al. v. Village of Port Chester, New York, et al.* If a corporation can have legal rights, responsibilities, and access, through its representatives, to the courts ("standing"), argues Stone, why not rivers? The merits and deficiencies of this notion are not important here, but its emergence at this time is a significant event (*43*).

The ultimate example, however, of the Noah Principle in operation has been provided by Dixon in a short but profound article on the case for the guarded conservation of *Variola*, the smallpox virus, as an endangered species (*44*):

> If we experience twinges of guilt about the impending extinction of large creatures, why should we feel differently about small ones? Conservationists lavish just as much time and energy on butterflies as they do on elephants. Why discount the microbes?

Dixon, in other parts of the article, makes a strong case for preserving smallpox as a resource (not for biological warfare, though), but his non-resource, "existence" value argument is clearly stated:

> Some of us who might happily bid farewell to a virulent virus or bacterium may well have qualms about eradicating forever a "higher" animal—whether rat or bird or flea—that passes on such microbes to man. . . . Where, moving up the size and nastiness scale (smallpox virus, typhoid fever bacilli, malarial parasites, schistosomiasis worms, locusts, rats . . .), does conservation become important? There is, in fact, no logical line that can be drawn.

It is not the purpose of this paper to discredit the economic and selfish uses of nature or to recommend the abandonment of the resource rationale for conservation. Selfishness in the sense of environmental exploitation, within bounds, is necessary for the survival of any species, ourselves included. Furthermore, should we rely exclusively on non-resource motivations for conservation, we would find, given the present state of world opinion and material aspirations, that there would soon be nothing left to conserve. But we have been much too careless in our use of resource arguments—distorting and exaggerating them for short-term purposes and allowing them to confuse and dominate our long-term thinking. Resource and non-resource reasons for conservation must always be presented together, and conservationists should make clear that the non-resource reasons are ultimately more significant in every case. If resource arguments seem legitimately strong there is no reason to ignore them, although they must be used with caution because of their potential to weaken the conservation position at unpredictable times and in unpredictable ways. Conversely, when a community or species has no known economic worth, there is no need either to trump up weak resource values for it or to abandon the effort to conserve it. Its non-resource value is enough to justify (but not necessarily to assure) its protection.

A number of years ago, Elton (*42*) proposed that there were three different reasons for the conservation of natural diversity: "because it is a right relation between man and living things, because it gives opportunities for richer experience, and because it tends to promote ecological stability—ecological resistance to invaders and to explosions in native populations." He stated that these reasons could be harmonized and that together they might generate a "wise principle of co-existence between man and nature." Since these words were written, we have ignored this harmony of conservation rationales, shrugging off the first, or religious, reason as embarrassing or ineffective and relying on inadequate but "hard scientific" proofs of value.

Allen (*45*), for example, in summing up his resource-type arguments for preserving diversity, has said that the economic climate is now such that "only the most severely practical arguments will prevail. Faint-hearted ecologists who fear that their favourite species *are* damned-well useless will just have to risk it. No doubt there is some redundancy in the system, but there are strong theoretical grounds for believing that most of the species on this planet are here for a better reason than that they are poor galactic map-readers."

What Allen is saying is that everything—including nearly all species—is interconnected and nearly everything has its own part to play in maintaining the natural order: consequently, nearly all species are significant, have resource value. Remove a species, even a seemingly trivial one from a resource standpoint, and we are more than likely to feel the consequences somehow, somewhere, someday (*46*). But have there been permanent and significant effects of the extinction, in the wild, of John Bartram's great discovery, the beautiful tree *Franklinia alatamaha*? Or a thousand species of tiny beetles that we never knew existed before or after their extermination? Can we even be certain that our eastern forests suffer the loss of their passenger pigeons and chestnuts in some tangible way that affects their vitality or permanence?

As a faint-hearted ecologist, I am not so certain that Allen's "strong theoretical grounds" can protect the Houston toad, the cloud forests, and a vast host of other living things that deserve a chance to play out their evolution unhindered by us. Nor am I willing to "risk it" on behalf of other creatures and communities that will suffer the immediate consequences if the risk fails. There is no genuine responsibility (or feedback) when the consequences of risk-taking are not borne by those who make the decisions.

If non-resource arguments are ever to carry their deserved weight, cultural attitudes will have to be changed. Morally backed missionary movements, such as the humane societies, are doing quite well these days, but I have no illusions about the chance of bringing about an ethical change in our Faustian culture without the prompting of some general catastrophe. What sort of change in world view would favor the conservation of non-resources? Nothing less than a rejection of the heroic, Western ethic with its implicit denial of man's biological roots and evolved structure.

Not all problems have acceptable solutions; I feel no constraint to predict one here. On the one hand, conservationists are unlikely to succeed in a general way using only the resource approach; and they will often hurt their own cause. On the other hand, an Eltonian combination of resource and non-resource arguments may also fail, and if it succeeds, as Mumford has implied, it will probably be because of forces that the conservationists neither expected nor controlled (*47*). But in this event we will at least be ready to take advantage of favorable circumstances—and will have had, whatever the outcome, the small, private satisfaction of having been honest for a while.

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