The Preservation of Natural Diversity: A Survey and Recommendations

The Nature Conservancy

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The Preservation of Natural Diversity

> "Not all the winds and storms and earthquakes and seas and seasons of the world have done so much to revolutionize the earth as Man. . .has done since the day he came forth upon it and received dominion over it." 1/

> "The first prerequisite of intelligent tinkering is to save all the pieces." 2/

America is losing ground. It is losing ground in quite the literal sense. As population and levels of affluence grow, urban areas are running together at their peripheries and the effects of development are becoming pervasive. With the rapid growth in recreational and second home development, agricultural reclamation of marginal lands, and the rush to exploit new energy sources, landscape alteration is reaching into even the most remote areas of our country. In the face of this onslaught, fewer and fewer areas retain much of their original natural character; the diversity of biotic species, ecological communities, and other natural elements stand on an ever narrowing base. The idea that our country is still relatively unpopulated with great expanses of wild land is without foundation. As David Ehrenfeld has noted, "No matter where one goes, nature is somewhere else."

In dealing with the problem of natural landscape destruction, we ought to recognize both a quantitative and a qualitative aspect. On the quantitative side, we need to concern ourselves with the stability of the entire ecosphere. For this purpose we need to

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1/ Horace Bush, from the title page of Man and Nature, George Perkins Marsh, 1864.

2/ Attributed to Aldo Leopold.

protect and carefully manage the largest possible land and water acreage of high productivity with coherent ecological functions.

The natural areas (or ecological reserves) movement is primarily concerned, however, with the qualitative aspect. Ecological components, particularly biological species, are neither universally distributed or perfectly interchangeable, but are instead restricted to certain geographic zones where they are highly adapted to local climate, soils, and the association of other organisms with which they coexist. Other components of natural landscapes, such as geological outcrops, typical or unique watershed types, or peculiar microclimates, are similarly uneven in their distribution.

Even making the reasonable projection that absolute growth will continue, at least for a few decades, a great deal can be accomplished by channeling that growth into less environmentally destructive patterns. To maximize the effectiveness of this approach in preserving diversity, we need to pay considerable attention to the ecological/environmental particulars of different kinds of landscapes. We need to set aside, in viable units, adequate examples of the full array of extant ecosystems, biological communities, endangered species habitats, and endangered physico-chemical environmental features. Only in this way can we maintain the full diversity of genetic variability, ecological relationships, and special processes and elements. It is not enough simply to set aside certain tracts of land where convenient. Unless we carefully set out to preserve the full array of extant natural types and species, many of these will be overlooked and

unnecessarily eliminated.

Although professional ecologists and natural scientists recognized the loss of natural landscape as a problem early in this century, the chief effects of early conservation efforts were, on the one hand, to extend protection to a large amount of land on government controlled forests and parks and on the other, to control through legal means certain of the most destructive practices such as slash and burn forestry and market hunting. Both of these efforts have had powerful protective effects, but even together they are not enough. The protection of specific lands has not yet been systematically conducted to ensure that the fullest possible spectrum of natural diversity is represented within the areas set aside. Many ecosystem types, features, and species have therefore fallen through the cracks. The more careful management of the rest of our lands still allows forms of disruption severe enough to destroy many ecological elements. Meanwhile, absolute growth and technological change have overwhelmed any serendipitous effects so that an increasing fraction of total diversity is in greater jeopardy of loss than ever before.

If nothing is done about this situation, it seems certain that species after species, community type after community type, ecological component after ecological component is going to be unnecessarily snuffed out of existence. The natural ecological fabric of the whole continent will be eaten away thread by thread right before our eyes. Yet except for a few underfunded efforts to preserve endangered species or pristine ecological

remnants, nothing systematic is being done about it.

This seems incredible. In searching for reasons for this inactivity, one realizes that there are probably at least three. First, ecological systems and events are enormously complex and dynamic, and we do not know exactly what the status of natural diversity is in this country. We have to study the problem before we can accurately gauge the need for concern. The situation is a little like that of bodily health. Even if there are some symptoms, tests must be taken before the disease can be diagnosed. We have been ignoring the excellent medical dictum of regular periodic check-ups.

Second, the first things that are being lost are the less dominant ecological elements that few people have ever cared about anyway. The average person has never heard of Steller's sea-cow, would have felt no pang over its extinction, and is equally ignorant and unconcerned about manatees.

Third, and most important, even if we knew what was being lost and cared about it, not may people seem to understand how important diversity is. People have at least some vague comprehension of their dependence on nature's life support systems. They know that the vegetables they eat grow on plants, that trees are the source of wood for their houses, and maybe even that microbes break down their waste products. They may know that bananas grow in the tropics and white pines grow in the north woods. They may even be aware that bananas will not grow in the north woods nor white pines in the tropics, but perhaps they have not made much of the fact. They probably do not know that white pines

need nitrogen-fixing bacteria to grow and probably never thought about why a forest might be better with twenty species of trees than just one. They don't realize that every single ecological element plays some role or has some attributes that could effect them. As it is, the fact that we need natural diversity has never penetrated the public consciousness.

Why Save Natural Diversity?

Many people seem to feel that the preservation of natural areas and ecological diversity is a trivial question of aesthetics or recreation. Such concerns are apparently considered by some to be mere elitist sentimentalism, quite apart from, and perhaps even antipathetic to, the serious and pressing matters before the human race. It is worth repeating a recent statement from a strange book written by a Manhattan urbanophile:

> I, personally, prefer diversity to homogeneity, but I realize that this desire for variety is probably not shared by most of the human race. I would like to argue for preservation of diversity, for the hell of it, and perhaps because some species, before they join the fossil kingdom, may have something important and fascinating to tell us. There is no arguing about tastes, and I hope the tour-promoters and the wealthy wild-animal lovers will persevere in their attempts to save the purple beaked lesser tit and her friends. I wish them success. But though I cheer them from the sidelines, there are more pressing problems that presently engage my concern.[1]

Besides patronizingly underrating "most of the human race", this same individual insouciantly states elsewhere that "the ecology of our apartment is sufficient to our needs without wild

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[1] Adler, Cy A. 1973. Ecological Fantasies. Green Eagle Press, N.Y., p. 261.

beasts and flowers." If so, the author's life support requirements must be magically supplied, without the bothersome complexities of soils and waters, or of biotic species with their adaptations, ecological needs, and evolutionary histories. The rest of us are not so fortunate, and must therefore look a little more deeply into this matter.

The arguments for preserving as much natural diversity as possible have not been made in a wholly satisfactory way anywhere, and only a few authors have dealt with the problem at any length. Worthwhile discussions may be found in books by David Ehrenfeld,[1] Aldo Leopold,[2] Charles Elton,[3] and Rezneat Darnell[4] and elsewhere, but the subject is still in need of a compelling magnum opus.

The following discussions constitute but a surface skim over this deep subject. The dominant themes are man's constant effort to warp natural systems to suit his fancy, to discard what he does not immediately see as useful, and his ultimate reliance, no matter how dimly understood, on the ecological systems and elements which he has ignored, disdained or even sought to destroy.

1/ Ehrenfeld, David W. 1972. Conserving Life on Earth. Oxford University Press, New York.

2/ Leopold, Aldo. 1949. Sand County Almanac. Oxford University Press, New York.

3/ Elton, Charles S. 1958. The Ecology of Invasions by Animals and Plants. Methuen & Co., London.

4/ Darnell, Rezneat M. 1973. Ecology and Man. W. C. Brown Co., Dubuque, Iowa.

Nature: Healer of Wounds

Deliberate environmental modification has been mankind's distinguishing behavioral characteristic. Utilizing tools to extend his personal power, he has extensively modified natural landscapes to maximize what he has perceived to be their immediate utility to him.

The effect has nearly always been ecosystem simplification as more and more species and natural elements which were regarded as competitive or of no value have been eliminated from the systems. Frequently, this activity has resulted in negative, even disastrous, side effects. Soil fertility has been depleted, hydrological and bio-geochemical cycles disrupted. Eventually the modified local system could no longer sustain even the chosen human activity or, consequently, human life and social systems. Characteristically when this happens, man has moved on, leaving an ecological wasteland in his wake.

But in this wreckage a remarkable thing happens. A long-dormant seed germinates -- then a few more. The birds, winds, and water bring others. At first only a few kinds of plants grow, on a wet spot in one place, a fertile siltation fan someplace else, but the process called ecological succession has begun. With the plants come the animals and, as time goes by, another and another life form finds its way back to the area, each occupying the niche to which it is adapted, one species replaced by two others as the earlier immigrants prepare the way for a richer array of life. The soil is restored, the complexity of food webs and other relationships grows. No matter how

devastating the original effect, natural succession will eventually heal the wounds made in the land by man, just as it eradicates the scars left by glaciers and other harsh geologic forces.

Finally even men may return, pronouncing the area "primeval" and setting about pushing all those "useless" organisms around again to more closely approximate the conditions they believe satisfactory. In some areas, human societies have even adapted themselves to the successional phenomena on a cyclical basis, practicing shifting agriculture or nomadic grazing as a continuing regimen.

Whether these peoples ever comprehend their indebtedness to the myriads of successional pioneers and lesser organisms is doubtful, but as long as all those organisms continue to exist, the ignorance of such peoples is at least not fatal.

This is not only a quaint story about the environs of remote aborigines or our distant ancestors. The process is operating right around us in the gradual recovery of the depleted mid-Atlantic tobacco lands and of the carnage left by the Lake States' timber barons. We make much of the fact that there is more forest in New England now than there was one hundred years ago, but we did not have to lift a hand to make it so. It was all done for us as a "free service" of nature, and each beech and maple grew on a spot prepared for it by some grass or forb or shrub or all of these which we can not even name without intensive research and experimentation.

The complexity of the phenomenon is even greater when one

extends its horizontal dimension. The trees which grow in Arizona are not the same trees which grow in Pennsylvania. In each region, a peculiar array of species play a part in the successional process. Adjacent regions may differ but slightly as a few species drop out and a few are added, but eventually, as distances become great, nearly total replacement occurs. This happens at least several times from north to south and east to west in North America.

Moreover, even within a single area, the species array differs greatly -- from one community to another, from ponds to dry land, from flood plain to hillside, and from northern exposure to southern exposure.

It is not anticipated that we will understand this process very soon, even for a single community in a single place. The vast complexity of interlocking relationships and the rapid succession of great numbers of simultaneously occurring instantaneous events may put a detailed operational understanding forever beyond our grasp. No doubt our predictive capability could gradually be improved, but whether we will ever understand the role or importance of each individual species in this chain of events is debatable. No doubt some can be removed from any given system without much apparent perturbation, but since we don't know which ones, prudence dictates a policy of retaining all we can.

In the past, this requirement took care of itself. There were always some refugia in which the diversity of life forms persisted, no matter how catastrophic the local impact of

disruption. At present we can no longer rely on such random perpetuation, since landscape alteration is more pervasive and permanent. More and more species, among the minority for which we have any information, reach endangered status as their habitats shrink. Agricultural areas now tend to become tomorrow's suburbs rather than tomorrow's old fields. Our megalopolitan areas are pushing up against each other at their fringes and whole regional ecosystems may be essentially paved and lawned over. What happens if and when a region's natural species are heavily depleted? What happens when we need those species and communities again?

The Reservoir of Resources

Most of this discussion about the value of diversity has pertained to the biological elements. Among the many reasons for this are the following. First, it is in the realm of biology where diversity reaches its zenith. Second, biological organisms and species suffer from the fact of mortality. A species can become extinct in a sense which does not apply to inorganic factors. Further, biotic species are especially vulnerable because their existence depends on a web of relationships, all of which must be preserved. Third, we ourselves are alive and depend on other organisms for our existence. Fourth, biological species reproduce.
This means that they are "renewable resources" and their relative abundance can be deliberately altered to serve our purposes. By choice we live in a world with perhaps several hundred million

cattle and several thousand bison. If we wished, we could in fairly short order reverse the ratio. A related fact is that the characteristics of an organism are the product of a particular mix of genetic and environmental factors, all of which are subject to variation and alteration. Therefore, if we feel the need for long-legged cattle or short-legged cattle we can probably produce them. Over the geographic range of a widespread, variable species, both long- and short-legged forms may even be found already to exist. No non-biological resource possesses either of these remarkable characteristics, much less both.

Each extant biological species, no matter how rare, is a potential resource of indefinite value. If there are as few as two individuals (or in some cases even one) of a species in existence, and we discover an important use for that species, it is possible to generate it in an almost infinite abundance. Since each species is a unique biochemical factory, each has some attributes unshared by any other. The number of instances in which such unique attributes instantly appreciate in the scale of perceived human values from "useless" to "priceless" is legion. Penicillium fungus is but a striking example.

There are people who spend their lives looking for species with as yet untapped utility. A special group called ethnobotanists have pursued this objective by finding out what a variety of other cultures do, or have done, with plant species of which we make no use. This enterprise has yielded everything from

medicines to macadamia nuts and continues to produce new resources. One recent book catalogues putative uses for over 5,000 little-known species.1/ Willaman and Schubert indexed the occurrence of potentially useful compounds called alkaloids in nearly 4,000 species of plants to facilitate further investigation.2/ The organisms of the tropical coral reef have lately become the source for a whole new pharmacologia.

This search for new resources is a currently important enterprise. The Medicinal Plant Resources Laboratory of the Agricultural Research Service is pursuing it along several lines. In one project, plants from all over the world are being systematically screened for compounds which show potential in cancer treatment. Substances called maytensines have shown exciting results in animals and are undergoing extensive testing for human treatment. They were found in Ethiopian species of the plant genus Maytenus, but those species did not produce enough of the compound for full investigation. Then another species which produced far more abundantly was discovered in a forest reserve in Kenya. After further testing, a more intensive effort was launched and related substances were found to be produced even better in species of the closely related genus Putterlikia. These were found in yet another forest reserve, this time in South Africa, and are now under consideration for serious

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1/ Altschul, S. von R. 1973. Drugs and Foods from Little-Known Plants. Harvard University Press, Cambridge.

2/ Willaman, J.J. and B.G. Schubert. 1961. Alkaloid-Bearing Plants and their Contained Alkaloids. U.S.D.A. Technical Bulletin 1234.

cultivation.

In another project, laboratory scientists are screening the seeds of American plants for oils with industrial potential. Some of the most promising results are from species of Lesquerella and Limnanthes, several of which are very localized endemics in the Southeast and California respectively. These have been placed on the new endangered plant list for the U.S.,[1/] and some of them could be totally wiped out by a single housing project.

In this field it is not unusual to find the solutions for problems in totally different geographic regions. Quinine, one of the most important early drug discoveries and found in plants indigenous to the South American Andes, is a specific for an Old World disease. On the other hand, when the problem is ecological, its solution is apt to be found in close proximity. As the dangers of pesticides are becoming better understood, for instance, integrated pest control strategies are being developed utilizing previously unrecognized predators or parasites to control agricultural pests or disruptive exotics.

Robert Ricklefs has given a good description of a case in which the predator was from the same region as the problem organism, but had to be transported half way around the world to be effective.

> An even more spectacular example of predator control is that of the Prickly Pear Cactus (Opuntia) and the Cactus Moth in Australia (Dodd 1959). When Prickly Pear Cactus was introduced to Australia, it spread rapidly throughout large portions of the island continent, covering thousands of acres of pasture and rangeland which otherwise could have been grazed by sheep.

1/ Smithsonian Institution, 1974. Report on Endangered and Threatened Plant Species of the United States.

> After several unsuccessful attempts to eradicate the Prickly Pear, a natural predator, the moth, Cactoblastis cactorus, was introduced to Australia from South America. The caterpillar of the Cactus Moth feeds on the growing shoots of the Prickly Pear and quickly destroys the plant. Within a matter of a few years, the Prickly Pear, which at one time covered thousands of square miles of Queensland, was a pest of the past. It persists only in small, isolated patches that Cactoblastis has failed to reach; in fact the Cactus Moth is not at all common now, even though it is effectively maintaining the Prickly Pear at low levels. The eradication of Opuntia in Australia has not been completed only because the cactus manages to disperse to predator-free areas, thereby keeping one jump ahead of the moth and maintaining a low-level equilibrium in a continually shifting mosaic of isolated patches. As Ehrlich and Birch (1967) pointed out, one would probably not guess that the Cactus Moth keeps the Prickly Pear at its present low population levels. The moths are actually relatively scarce in the remaining stands of cactus in Australia today. The same moth is probably responsible for controlling the prickly pear in some areas of Central and South America, but its decisive role would not have been apparent without the observation of the appropriate "experiment" in Australia.[1/] (Emphasis added).

The point about not recognizing the Cactus Moth's effect reinforces the theme expressed here in many places -- that our impression of a species' "uselessness" is not a good criterion for action. What would have happened if in some fashion the Cactoblastis moth had become extinct? Waiting out the evolution of a new biotic species capable of controlling Opuntia might try the patience of an oyster. Pests are often created by an ecosystem disruption which frees a species from existing biotic control factors such as a predator. As long as the predator species exists somewhere, re-establishment of its control is a possibility, but if it should become extinct, then what?

1/ Richlefs, Robert E. 1973. Ecology. Chiron Press, Newton, Massachusetts. p. 534.

In a spare moment one might wrestle with the problem of placing a particular value in the resource potential of any given species. (Because of the geometric increase factor, the exercise is somewhat reminiscent of the story about the Caliph and the chessboard. He all too quickly agreed to put one grain of rice on the first square, two on the second, four on the third, etc., until he discovered that he had given away the total world rice production for a few thousand years.) One of the most economically valuable non-human species is wheat (a complex of several species). The price paid farmers for this year's wheat crop in the U.S. alone was $6,500,728,000, and the total world crop must have been worth at least $30 billion.[1/] If that were the recognized potential value per year of any given species, people would pay more attention to the care and perpetuation of each one.

Wheat is a good example for exploration of the value of genetic diversity within a species. Elsewhere there is some mention of the shortcomings of crop monocultures, including those of wheat. We create monocultures because, on one level, we can utilize them efficiently. However, they also are ideal for efficient disease transmission and for exploitation by our competitor consumers. We manipulate the situation in a variety of ways to minimize our losses to diseases and pests, most importantly perhaps, by constantly developing new varieties with resistant properties. Diseases and pests have properties which preadapt them for this sort of struggle, however, and they develop

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1/ U.S.D.A. 1974. Agricultural Statistics - 1974. Government Printing Office, Washington.

the ability to overcome the innate resistance of the latest varieties almost as fast as we can develop them. Small grains like wheat are the chief basis of human subsistence and under present conditions, this situation has been rather frighteningly referred to as the "race between agricultural research stations and catastrophe".

One of the principal resources for the agricultural scientists has been the genetic diversity of the whole wheat species complex including the wild progenitors. By selection and interbreeding different varieties it has been possible to continue to generate new recombinations with needed characteristics, but the elimination of the wild wheat habitats and the consequent narrowing of the genetic base is cause for grave questions about the future. Agricultural scientists have been expressing their increasingly serious concern, not just about wheat, but about the loss of genetic diversity in nearly every major crop species.1/

Indeed, it is true that the perceived value of a species may rise and fall like the stock market. Among the most ubiquitous plant species in the world is the common reed (Phragmites communis). It grows from the arctic to the tropics in nearly any fresh or near fresh water situation. We can not find much to do with it today except to make special pens for calligraphers or to adorn a winter bouquet, but for the Babylonians 3,000 years ago, it was like the bison to the American Indian. They ate it, they dressed with it, they wrote on and with it, they built

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1/ "Genetic Erosion: Crop Plants Threatened by Government Neglect," Science, Vol. 182: 21 December 1973.

houses of it and used it to cremate their dead. It still has the same properties and who can say we will never find needs for it again.

All of these spectacular examples have a sort of unreality about them akin to finding a thousand dollar bill on the street. You can't plan for such things, but like any occurrence with a certain probability, eventually it is bound to happen.

The way to guarantee good luck is to plan ahead. By setting aside selected areas of the natural landscape representing the full range of communities with their component species, we can create a resource bank of incalculable value which is sure to yield critical, irreplaceable and therefore priceless resources to meet unanticipated future needs.

The Ecological Library

Probably the majority of living ecologists believe that ecological diversity is directly correlated with environmental stability -- the more diverse an ecosystem, the less subject it is to great fluctuations in any of its parts and the better it is buffered against external disruption. This is assumed to be because of overlap and redundancy in the web of relationships. Any particular herbivore, for instance, is preyed upon by several types of predators so that the disappearance of one type would not lead to uncontrolled growth in the population of the herbivore. Conversely, each predator utilizes a variety of prey species, so the loss of any single one will not lead to starvation of the predator.

Of course the primitive state of our ecological understanding

makes every question a matter of debate and there is great disagreement about the details of this phenomenon. One can read with fascination, for example, the differing viewpoints expressed during the famous Brookhaven Symposium.[1/] One only regrets that in cases like this, any non-unanimity of opinion is seized upon as excellent justification for ignoring the problem.

For our purpose what is truly germane is that diverse natural ecological systems work with a comparatively high degree of reliability. 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 salient point of difference between the two types of systems is that the man-dominated ones have been subject to great ecological simplification. Ecologists may disagree over such details as whether there is a point beyond which additional diversity has no effect, whether an equilibrium is eventually established, or whether there is a maximum amount of diversity a system can sustain. At the other extreme, however, ecologists are unanimous in agreeing that systems without substantial diversity, exemplified by crop monocultures, are quite unstable.

To expand on a point made earlier, we simplify ecosystems basically because human beings occupy the ecological niche of consumer. We chiefly modify ecological systems to maximize the

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1/ Diversity and Stability in Ecological Systems. 1969. Brookhaven Symposia in Biology: Number 22. Brookhaven National Laboratory, Upton, New York.

fraction of the total energy flow which passes through the particular food chain which ends in us. Insofar as possible, any producer organism which does not produce as much as possible in the way of food which we can readily consume is eliminated. Any other organism which happens to consume the same types of food is also eliminated. Other organisms may be for the most part ignored. If human beings were as dietarily specialized as Monarch butterflies, our treatment of the landscape would no doubt tend toward the creation of a world covered with milkweed and without any Monarch butterflies. Of course the butterflies, having purposes of their own, would instead become our major crop pest. Unless we could stop them, they would eat everything and we would all starve.

Reductio ad absurdum has its uses, and the localized situation with our monocultural food crops is not so different from this. Fortunately we need and desire more than a single kind of food, also require fiber, and do not "live by bread alone". Nevertheless, we have simplified the ecology of our human environments to a tremendous degree with markedly detrimental results.

If we are ever to create more stable and successful human environments (and it is neither possible nor desirable for us to cease our wholly human manipulative ways) we will always need many examples of each type of natural ecosystem as models of healthy function and as libraries of information to which we can turn at need. We need to analyze those systems to see why they work as they do, what the critical factors in their function are, and

how we can modify our manipulated systems to emulate them. We have only made the barest beginnings in this direction, most notably through the Ecosystems Analysis programs of the International Biological Program. Just as one can only learn so much about healthy body function from the study of disease, so one can only learn a little about healthy ecosystem function from a study of damaged ecosystems. Without preserving significant representatives of all sorts of natural ecosystems we will not be able to go much further without running into blind alleys and unanswerable questions.

A closely related use of protected natural areas is as environmental monitoring stations. Because they are ordinarily protected against intensive exposure to various disruptive treatments and management practices, they should be excellent sites for measuring ambient conditions. For example, they will not be exposed to direct pollution by industrial chemicals, suffer soil disturbance, or things of this kind, so that the measurement of the ordinary by-products of such influences on ecological reserves will provide us with perspective on changes in the total environment.

Because an ecological reserve system would contain many rare, often specialized, species not common or extant elsewhere, the value of reserves in environmental monitoring would be considerably augmented. The greater the diversity of species, the greater the likelihood of some of them possessing characteristics such as high specific sensitivity to certain substances. Such organisms are spoken of as "indicator species," and their reactions

may more accurately reflect particular environmental influences than any scientific instruments. The example of the miner's canary may be a bit trite, but it is nonetheless apt. Just as the canary will display distress from poisonous gases before miners (giving the latter time to escape), some lichens, for example, will wither if exposed to low concentrations of nitrous oxides, giving notice of the need to take action.

A broad selection of preserved natural areas representing the full diversity of communities, habitats, and ecological phenomena is also an irreplaceable resource for the establishment of ecological baselines.[1/] All of our landscape manipulations represent ecological experiments, and no experiment is complete without a control. By comparing variables on natural areas and manipulated ones, we have a mechanism which can be used to detect differences between trivial changes and diverging trends indicative of serious environmental decay. It has been suggested for years that we deliberately establish selected natural area controls as part of any large public works project or major landscape alteration. The idea has much merit.

Though most of this discussion has dealt with the value of biological diversity, this cannot in practice be separated from the diversity of geological, hydrological, edaphic, climatic, and other environmental variables. All of these play roles in the function of the total ecosystem, as well as possessing individual attributes and significance. In the area of information, this

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1/ Jenkins, R.E. and W.B. Bedford. 1973. "The Use of Natural Areas to Establish Environmental Baselines," Biological Conservation, Volume 5 , Number 3.

point can be quite clearly made. Geologists, hydrologists, soil scientists, meteorologists, and other natural scientists are as dependent on their natural libraries as are ecologists. A national ecological reserve system would take this into account and incorporate as much of the diversity represented among these elements as practicably possible.

Conclusion

Obviously the matter of preserving as much ecological diversity as possible is important, but what must we do? In order to accomplish this objective, what is needed now is an efficacious governmental focal point that will direct a systematic process to carefully inventory the nation, ascertain the condition of various ecological elements, identify areas which collectively contain the fullest spectrum of ecological diversity, and then provide protection for the ones not already preserved. Various aspects of this subject have been treated elsewhere, 1/ 2/ 3/ and the general point is elaborated at some length in the recommendations of this report.

1/ Jenkins, R., 1972. "A National Natural Areas Inventory," The Nature Conservancy News, 22(3).

2/ Jenkins, R., 1973. "Preservation of Ecosystems: A Status Report," Atlantic Naturalist 28(2).

3/ Moyseenko, H., 1974. "A Comprehensive Natural Areas Program," The Nature Conservancy News. 24(3).

However, several things remain to be said. There is a lot to do and no time to waste, but society also has other pressing business. How hard is this job going to be and what is the likelihood that it can be successfully accomplished?

There are good reasons to think that it is an eminently accomplishable task. One would have to look far to find something with as much potential for good and as little for harm. The approach to be taken is not a negative one, but depends on positive action to arrange growth patterns in a less destructive manner. It is an enterprise which society, therefore, generally ought not to oppose.

Moreover, besides the lack of spirited resistance to the idea, active support could be expected from a large number of involved individuals and groups scattered through a loose but vigorous confederation of interests. This confederation would include advocates of nature preserves, wildlife refuges, outdoor recreation areas, wildflower sanctuaries, research natural areas, biological field stations, genetic reservoirs, endangered species sites, and environmental baseline sites.

The goal of preserving natural diversity is thus more than compatible with many ongoing efforts and program. In some cases there is a potential for synergistic action. Not long ago, The Nature Conservancy had a hand in helping to preserve nearly 1,000 acres of

tropical forest on the Caribbean island of Dominica. From our point of view it was an outstanding example of rain forest in the Caribbean and the habitat for a large number of species and other ecological elements. Its preservation was facilitated, however, by the fact that it is mostly steep and relatively undevelopable land. It is also part of the water supply basin for the capital city, and has considerable importance as a visual amenity and a potential site for non-destructive recreational visitation. By careful selection of ecological reserves, such multiple benefits can frequently be provided with attendant economies.

There is going to be a lot of open space in most parts of the U.S. for a foreseeable period into the future. What matters for our purposes is its distribution. It is not necessary to swim upstream against all the momentum of development in order to preserve natural diversity, but only to breast the tide in places and make it wash around, instead of over, the spots containing the natural systems requiring protection. Among a large number of growth pattern alternatives, there is probably no net cost difference to society as a whole. A modest expenditure on planning and some muscle exerted in seeing that the plan isn't totally ignored could work wonders.

It seems just short of miraculous that the preservation of diversity has not become a basic raison d'etre for land use

planning. Instead, the land use planning movement has concentrated upon matters of carrying capacity and development constraint. Most likely a great deal more could be accomplished by gearing the effort more toward protecting what is valuable.

Beyond land use planning, the uses of the proposed ecological reserve system, or parts of it, are many. The process of environmental impact assessment, for example, could be greatly improved by the perspective which a natural areas data bank could provide. At present, the process is entirely too site-specific, and the lack of comparative data is severely constraining. If anyone required to do an impact statement could know in advance what aspects of the natural environment he should record or measure and where he could go to compare his data with similar data drawn from a wide geographic region, this would constitute about the best method imaginable for improving the process. This is just one potentially beneficial side-effect of a strong focus on ecological diversity.

In closing, it must be noted that Adler was quite wrong in his estimate of the preferences of his fellow human beings. There is probably no one in the world who is indifferent to diversity in their environment. Practically any human endeavor that we characterize as enjoyable either directly depends on, or is greatly improved by, the factor of diversity. "Variety," some

now forgotten source proclaimed, "is the spice of life."

This can not be an accidental phenomenon. It is too intimately bound up with the whole human aesthetic sense and has too much influence over our behavioral reactions to be less than directly related to our very survival instincts. A logical presumption would be that in the distant past when so many attributes were being imprinted into the human animal by the uncompromising forces of natural selection, a positive reaction to natural diversity conferred a survival advantage. No doubt the same sorts of diverse landscapes which still exert a strong attraction to us now, then connoted important facts of richness, abundance, and reliability. It was not fortuitous that we grew to love these things, and it seems especially poignant that our inherent love for diversity strongly persists right to the present, when diversity is so imminently threatened with destruction.