

# What's Wrong with Plastic Trees?

Rationales for preserving rare natural environments involve economic, societal, and political factors.

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A tree's a tree. How many more [redwoods] do you need to look at? If you've seen one, you've seen them all.—Attributed to Ronald Reagan, then candidate for governor of California (1).

A tree is a tree, and when you've seen one redwood, given your general knowledge about trees, you have a pretty good idea of the characteristics of a redwood. Yet most people believe that when you've seen one, you haven't seen them all. Why is this so? What implications does this have for public policy in a world where resources are not scarce, but do have to be manufactured; where choice is always present; and where the competition for resources is becoming clearer and keener (2; 3, pp. 1-13)? In this article,

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I attempt to explore some of these issues, while trying to understand the reasons that are given, or might be given, for preserving certain natural environments (4, 5).

## The Ecology Movement

In the past few years, a movement concerned with the preservation and careful use of the natural environment in this country has grown substantially. This ecology movement, as I shall call it, is beginning to have genuine power in governmental decision-making and is becoming a link between certain government agencies and the publics to which they are responsible. The ecology movement should be distinguished from related movements concerned with the conservation and wise use of natural resources. The latter,

ascendant in the United States during the first half of this century, were mostly concerned with making sure that natural resources and environments were used in a fashion that reflected their true worth to man. This resulted in a utilitarian conception of environments and in the adoption of means to partially preserve them—for example, cost-benefit analysis and policies of multiple use on federal lands.

The ecology movement is not necessarily committed to such policies. Noting the spoliation of the environment under the policies of the conservation movement, the ecology movement demands much greater concern about what is done to the environment, independently of how much it may cost. The ecology movement seeks to have man's environment valued in and of itself and thereby prevent its being traded off for the other benefits it offers to man.

It seems likely that the ecology movement will have to become more programmatic and responsive to compromise as it moves into more responsible and bureaucratic positions vis-à-vis governments and administrative agencies. As they now stand, the policies of the ecology movement may work against resource-conserving strategies designed to lead to the movement's desired ends in 20 or 30 years. Meier has said (6, p. 217):

The best hope, it seems now, is that the newly evolved ideologies will progress as social movements. A number of the major tenets of the belief system may then be

expected to lose their centrality and move to the periphery of collective attention. Believers may thereupon only "satisfice" with respect to these principles; they are ready to consider compromises.

What is needed is an approach midway between the preservationist and conservationist-utilitarian policies. It is necessary to find ways of preserving the opportunity for experiences in natural environments, while having, at the same time, some flexibility in the alternatives that the ecology movement could advocate (7).

A new approach is needed because of the success of economic arguments in the past. We are now more concerned about social equity and about finding arguments from economics for preserving "untouched" environments. Such environments have not been manipulated very much by mankind in the recent past (hundreds or thousands of years) (8). Traditional resource economics has been concerned not as much with preservation as with deciding which intertemporal (the choice of alternative times at which one intervenes) use of natural resources over a period of years yields a maximum return to man, essentially independent of considerations of equity. If one believes that untouched environments are unlikely to have substitutes, then this economics is not very useful. In fact, a different orientation toward preservation has developed and is beginning to be applied in ways that will provide powerful arguments for preservation. At the same time, some ideas about how man experiences the environment are becoming better understood, and they suggest that the new economic approach will be in need of some modification, even if most of its assumptions are sound.

I first examine what is usually meant by natural environments and rarity; I will then examine some of the rationales for preservation. It is important to understand the character and the weak points of the usual arguments. I also suggest how our knowledge and sophistication about environments and our differential access to them are likely to lead to levers for policy changes that will effectively preserve the possibility of experiencing nature, yet offer alternatives in the management of natural resources.

One limitation of my analysis should be made clear. I have restricted my discussion to the nation-state, particularly to the United States. If it were

possible to take a global view, then environmental questions would be best phrased in terms of the world's resources. If we want undisturbed natural areas, it might be best to develop some of them in other countries. But we do not live in a politically united world, and such a proposal is imperialistic at worst and unrealistic at best. Global questions about the environment need to be considered, but they must be considered in terms of controls that can exist. If we are concerned about preserving natural environments, it seems clear that, for the moment, we will most likely have to preserve them in our own country (9).

### The American Falls: Keeping It Natural

For the last few thousand years, Niagara Falls has been receding. Water going over the Falls insinuates itself into crevices of the rock, freezes and expands in winter, and thereby causes cracks in the formation. The formation itself is a problem in that the hard rock on the surface covers a softer substratum. This weakness results not only in small amounts of erosion or small rockfalls, but also in very substantial ones when the substratum gives way. About 350,000 cubic yards (1 cubic yard equals 0.77 cubic meter) of talus lie at the base of the American Falls.

The various hydroelectric projects that have been constructed during the years have also affected the amount of water that flows over the Falls. It is now possible to alter the flow of water over the American Falls by a factor of 2 and, consequently, to diminish that of the Horseshoe (Canadian) Falls by about 10 percent.

As a result of these forces, the quality of the Falls—its grandeur, its height, its smoothness of flow—changes over the millenia and the months.

There is nothing pernicious about the changes wrought by nature; the problem is that Americans' image of the Falls does not change. Our ideal of a waterfall, an ideal formed by experiences with small, local waterfalls that seem perfect and by images created by artists and photographers, is not about to change without some effort (10, 11).

When one visits the Falls today, he sees rocks and debris at the base, too much or too little water going over the

edge, and imperfections in the flow of water. These sights are not likely to make anyone feel that he is seeing or experiencing the genuine Niagara Falls. The consequent effects on tourism, a multimillion-dollar-per-year industry, could be substantial.

At the instigation of local forces, the American Falls International Board has been formed under the auspices of the International Joint Commission of the United States and Canada. Some \$5 to \$6 million are being spent to investigate, by means of "dewatering" the Falls and building scale models, policies for intervention. That such efforts are commissioned suggests that we, as a nation, believe that it is proper and possible to do something about the future evolution of the Falls. A "Fall-scape" committee, which is especially concerned with the visual quality of the Falls, has been formed. It suggests that three strategies, varying in degree of intervention, be considered (12, 13).

1) The Falls can be converted into a monument. By means of strengthening the structure of the Falls, it is possible to prevent rockfalls. Also, excess rock from the base can be removed. Such a strategy might cost tens of millions of dollars, a large part of this cost being for the removal of talus.

2) The Falls could become an event. Some of the rocks at the base could be removed for convenience and esthetics, but the rockfalls themselves would not be hindered. Instead, instruments for predicting rockfalls could be installed. People might then come to the Falls at certain times, knowing that they would see an interesting and grand event, part of the cycle of nature, such as Old Faithful.

3) The Falls might be treated as a show. The "director" could control the amount of water flowing over the Falls, the size of the pool below, and the amount of debris, thereby producing a variety of spectacles. Not only could there be *son et lumière*, but it could take place on an orchestrated physical mass.

Which of these is the most nearly natural environment? Current practice, exemplified by the National Park Service's administration of natural areas, might suggest that the second procedure be followed and that the Falls not be "perfected." But would that be the famous Niagara Falls, the place where Marilyn Monroe met her fate in the movie *Niagara*? The answer to this question lies in the ways in which efforts at

preservation are presented to the public. If the public is seeking a symbolic Falls, then the Falls has to be returned to its former state. If the public wants to see a natural phenomenon at work, then the Falls should be allowed to fall.

Paradoxically, the phenomena that the public thinks of as "natural" often require great artifice in their creation. The natural phenomenon of the Falls today has been created to a great extent by hydroelectric projects over the years. Esthetic appreciation of the Falls has been conditioned by the rather mundane considerations of routes of tourist excursions and views from hotel windows, as well as the efforts of artists.

I think that we can provide a smooth flow of water over the Falls and at the same time not be completely insensitive to natural processes if we adopt a procedure like that described in the third proposal. Niagara Falls is not virgin territory, the skyscrapers and motels will not disappear. Therefore, an aggressive attitude toward the Falls seems appropriate. This does not imply heavy-handedness in intervention (the first proposal), but a willingness to touch the "sacred" for esthetic as well as utilitarian purposes.

The effort to analyze this fairly straightforward policy question is not trivial. Other questions concerning preservation have fuzzier boundaries, less clear costs (direct and indirect), and much more complicated political considerations. For these reasons, it seems worthwhile to examine some of the concepts I use in this discussion.

### Natural Environments

What is considered a natural environment depends on the particular culture and society defining it. It might be possible to create for our culture and society a single definition that is usable (that is, the definition would mean the same thing to many people), but this, of course, says nothing about the applicability of such a definition to other cultures. However, I restrict my discussion to the development of the American idea of a natural environment (10, 14, 15).

The history of the idea of the wilderness is a good example of the development of one concept of natural environment. I follow Nash's discussion (14) in the following.

A wilderness may be viewed as a state of mind, as an attitude toward a

collection of trees, other plants, animals, and the land on which they all exist. The idea that a wilderness exists as a product of an intellectual movement is important. A wilderness is not discovered in the sense that some man from a civilization looked upon a piece of territory for the first time. It is the meanings that we attach to such a piece of territory that convert it to a wilderness.

The Romantic appreciation of nature, with its associated enthusiasm for the "strange, remote, solitary and mysterious" (14, p. 47), converted territory that was a threatening wildland into a desirable area capable of producing an invigorating spirit of wilderness. The "appreciation of the wilderness in this form began in cities" (14, p. 44), for whose residents the wildland was a novelty. Because of the massive destruction of this territory for resources (primarily timber), city dwellers, whose livelihood did not depend on these resources and who were not familiar with the territory, called for the preservation of wildlands. At first, they did not try to keep the most easily accessible, and therefore most economically useful, lands from being exploited, but noted that Yellowstone and the Adirondacks were rare wonders and had no other utility. They did not think of these areas as wilderness, but as untouched lands. Eventually, a battle developed between conservationists and preservationists. The conservationists (Pinchot, for example) were concerned with the wise use of lands, with science and civilization and forestry; the preservationists (Muir, for example) based their argument on art and wilderness. This latter concept of wilderness is the significant one. The preservationists converted wildland into wilderness—a good that is indivisible and valuable in itself.

This capsule history suggests that the wilderness, as we think of it now, is the product of a political effort to give a special meaning to a biological system organized in a specific way. I suspect that this history is the appropriate model for the manner in which biological systems come to be designated as special.

But it might be said that natural environments can be defined in the way ecosystems are—in terms of complexity, energy and entropy flows, and so on (16). This is true, but only because of all the spadework that has gone into developing in the public a consensual picture of natural environ-

ments. What a society takes to be a natural environment is one.

Natural environments are likely to be named when there are unnatural environments and are likely to be noted only when they are outnumbered by these unnatural environments. The wildlands of the past, which were frightening, were plentiful and were not valued. The new wilderness, which is a source of revitalization, is rare and so valued that it needs to be preserved.

### When Is Something Rare?

Something is considered to be rare when there do not exist very many objects or events that are similar to it. It is clear that one object must be distinguishable from another in order to be declared rare, but the basis for this distinction is not clear.

One may take a realist's or an idealist's view of rarity. For the realist, an object is unique within a purview: given a certain boundary, there exists no other object like it. Certainly the Grand Canyon is unique within the United States. Perhaps Niagara Falls is also unique. But there are many other waterfalls throughout the world that are equally impressive, if not of identical dimensions.

For the idealist, a rare object is one that is archetypal: it is the most nearly typical of all the objects it represents, having the most nearly perfect form. We frequently preserve archetypal specimens in museums and botanical gardens. Natural areas often have these qualities.

A given object is not always rare. Rather, it is designated as rare at one time and may, at some other time, be considered common. How does this happen? Objects become rare when a large number of people change their attitudes toward them. This may come about in a number of ways, but it is necessary that the object in question be noticed and singled out. Perhaps one individual discovers it, or perhaps it is common to everyone's experience. Someone must convince the public that the object is something special. The publicist must develop in others the ability to differentiate one object from among a large number of others, as well as to value the characteristic that makes the particular object different. If he convinces a group of people influential in the society, people who are able to affect a much larger group's

beliefs, then he will have succeeded in his task. Thus it may be important that some form of snob appeal be created for the special object.

In order to create the differentiations and the differential valuations of characteristics, information and knowledge are crucial. A physical object can be transformed into an instrument of beauty, pleasure, or pride, thereby developing sufficient characteristics to be called rare, only by means of changing the knowledge we have of it and of its relation to the rest of the world. In this sense, knowledge serves an important function in the creation of rare environments, very much as knowledge in society serves an important function in designating what should be considered natural resources (17).

Advertising is one means of changing states of knowledge—nor does such advertising have to be wholly sponsored by commercial interests. Picture post cards, for example, are quite effective (18):

... a large number of quiet beauty spots which in consequence of the excellence of their photographs had become tourist centres. . . .

The essential was to "establish" a picture, e.g., the Tower [of London] with barges in the foreground. People came to look for the barges and in the end wouldn't have the Tower without barges. Much of the public was very conservative and, though such things as high-rise building and general facade-washing had made them [the post card producers] re-photograph the whole of London recently, some people still insisted on the old skyline, and grubby facades, and liked to believe certain new roads had never happened.

Similarly, the publicity given to prices paid at art auctions spurs the rise of these prices (19).

As a result of the social process of creating a rare object, the usual indicators of rarity become important. Economically, prices rise; physically, the locations of the rare objects become central, or at least highly significant spatially; and socially, rare objects and their possessors are associated with statuses that are valued and activities that are considered to be good.

### Environments Can Be and Are Created

To recapitulate, objects are rare because men decide that they are and, through social action, convince others that they are. The rarity of an object is created through four mechanisms:

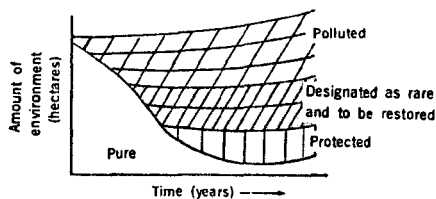


Fig. 1. The development of rare environments.

designating the object as rare; differentiating it from other objects of the same species; establishing its significance; and determining its position in the context of society. The last two mechanisms are especially important, for the meaning that an environment has and its relation to other things in the society are crucial to its being considered rare. That a rare environment be irreproducible or of unchanging character is usually a necessary preliminary to our desire to preserve it. Technologies, which may involve physical processes or social organization and processes, determine how reproducible an object is, for we may make a copy of the original or we may transfer to another object the significance attached to the original. (Copying natural environments may be easier than copying artistic objects because the qualities of replicas and forgeries are not as well characterized in the case of the natural environment.) Insofar as we are incapable of doing either of these, we may desire to preserve the original environment.

In considering the clientele of rare environments, one finds that accessibility by means of transportation and communication is important. If there is no means of transportation to a rare environment, then it is not likely that the public will care about that environment. An alternative to transportation is some form of communication, either verbal or pictorial, that simulates a feeling of being in the environment.

I am concerned here with the history of environments that, at first, are not considered unique. However, a similar argument could be applied to environments regarded as unique (for example, the Grand Canyon), provided they were classed with those environments most like them. Figure 1 should aid in the explanation that follows.

For example, suppose that a particular kind of environment is plentiful and that, over a period of time, frequent use causes it to become polluted. (Note that pollution need not refer just to our

conventional concepts of dirtying the environment, but to a wide variety of uncleanness and stigma as well.) Because there is a substantial amount of that environment available, man's use of it will, at first, have little effect on his perception of its rarity. As time goes on, however, someone will notice that there used to be a great deal more of that particular environment available. Suddenly, the once vast quantities of that environment begin to look less plentiful. The environment seems more special as it becomes distinguishable from the polluted environments around it. At that point, it is likely that there will be a movement to designate some fraction of the remaining environment as rare and in need of protection. There will also be a movement to restore those parts of the environment that have already been polluted. People will intervene to convert the polluted environment to a simulation of the original one (20).

### Reasons for Preservation

That something is rare does not imply that it must be preserved. The characteristics that distinguish it as rare must also be valued. Arguments in favor of preserving an object can be based on the fact that the object is a luxury, a necessity, or a merit.

We build temples or other monuments to our society (often by means of preservation) and believe that they represent important investments in social unity and coherence. If a forest symbolizes the frontier for a society and if that frontier is meaningful in the society's history, then there may be good reasons for preserving it. An object may also be preserved in order that it may be used in the future. Another reason, not often given but still true, for preserving things is that there is nothing else worth doing with them. For example, it may cost very little to preserve something that no one seems to have any particular reason for despoiling; therefore, we expend some small effort in trying to keep it untouched.

Natural environments are preserved for reasons of necessity also. Environments may provide ecological samples that will be useful to future generations. Recently, the long-lived bristlecone pine has helped to check radiocarbon dating and has thereby revised our knowledge of early Europe (21). It may

be that the preservation of an environment is necessary for the preservation of an ecosystem and that our destruction of it will also destroy, as a product of a series of interactions, some highly valued aspects of our lives. Finally, it may be necessary to preserve environments in order that the economic development of the adjacent areas can proceed in a desired fashion.

Other reasons for preservation are based on merit: it may be felt by the society that it is good to preserve natural environments. It is good for people to be exposed to nature. Natural beauty is worth having, and the amenity resulting from preservation is important.

### Rarity, Uniqueness, and Forgery:

#### An Artistic Interlude

The problems encountered in describing the qualities that make for "real" artistic experiences and genuine works of art are similar to those encountered in describing rare natural objects. The ideas of replica and forgery will serve to make the point (22, 23).

Kubler (22) observes that, if one examines objects in a time sequence, he may decide that some are prime objects and the rest are replicas. Why should this be so? One may look at the properties of earlier objects and note that some of them serve as a source of later objects; however, since the future always has its sources in the present, any given object is a source. Therefore, one must distinguish important characteristics, perhaps arbitrarily, and say that they are seminal. Prime objects are the first to clearly and decisively exhibit important characteristics.

Why are there so few prime objects? By definition, prime objects exhibit characteristics in a clear and decisive way, and this must eliminate many other objects from the category; but why do artists not constantly create new objects, each so original that it would be prime? Not all artists are geniuses, it might be said. But this is just a restatement of the argument that most objects do not exhibit important characteristics in a clear, decisive manner. It might also be said that, if there are no followers, there will be no leaders, but this does not explain why some eras are filled with prime works and others are not.

Kubler suggests that invention, especially if too frequent, leads to chaos, which is frightening. Replication is

calmer and leads only to dullness. Therefore, man would rather repair, replicate what he has done, than innovate and discard the past. We are, perhaps justifiably, afraid of what the prime objects of the future will be. We prefer natural environments to synthesized ones because we are familiar with techniques of managing the natural ones and know what the effects of such management are. Plastic trees are frightening.

What about those replicas of prime objects that are called forgeries? Something is a forgery if its provenance has been faked. Why should this bother us (24)? If the forgery provides us with the same kind of experience we might have had with the original, except that we know it is a forgery, then we are snobbish to demand the original. But we do not like to be called snobs. Rather, we say that our opinion of the work, or the quality of our experience of it, depends on its context. History, social position, and ideology affect the way in which we experience the object. It may be concluded that our appreciation of something is only partly a product of the thing itself.

Art replicas and forgeries exist in a historical framework. So do the prime and genuine objects. And so do natural environments.

#### Criteria for Preservation

Whatever argument one uses for preservation, there must be some criteria for deciding what to preserve. Given that something is rare and is believed to be worth preserving, rarity itself, as well as economic, ecological, or socio-historical reasons, can be used to justify preservation. I consider each of these here.

There are many economic reasons for planned intervention to achieve preservation, and I discuss two of them: one concerns the application of cost-benefit analysis to preservation; the other concerns the argument that present value should be determined by future benefits.

The work of Krutilla is an ingenious application of economics; it rescues environments from current use by arguing for their future utility (25). The crux of the argument follows.

Nature is irreproducible compared to the materials it provides. As Barnett and Morse have shown, there have been enough substitutions of natural materials to obviate the idea of a shortage of natural resources (3, pp. 164-216). It

also seems likely that the value of nature and of experiences in nature will increase in the future, while the supply of natural environments will remain constant. Because it is comparatively easy to produce substitutes for the materials we get from natural environments, the cost of not exploiting an environment is small, compared to the cost of producing that environment. Finally, there is an option demand for environments: that is, there will be a demand, at a certain price, for that environment in the future. If a substantial fraction of the supply of the environment is destroyed now, it will be impossible to fill the demand in the future at a reasonable price. Therefore, we are willing to pay to preserve that option (25, 26). The problem is not the intertemporal use of natural environments (as it is for natural resources), but the preservation of our options to use environments in the future, or at least the reduction of uncertainty about the availability of environments in the future (27).

Fisher (28) has applied optimal investment theory, including a possibility of restoring environments to a quasi-natural state, to the problem of preservation as formulated by Krutilla. Krutilla *et al.* (29) have applied an analysis similar to Fisher's to the preservation of Hell's Canyon (27).

Robinson has criticized Krutilla's argument from the following perspectives (30): he suggests that the amenity valued so highly by Krutilla (25) is not necessarily that valuable; that the experiences of nature are reproducible; that refraining from current use may be costly; and that the arguments for public intervention into such environments depend on the collective consumption aspects of these environments. That is, these environments benefit everyone, and, since people cannot be differentially charged for using them, the public must pay for these environments collectively, through government. It is well known that the users of rare environments tend to be that small fraction of the population who are better off socially and economically than the majority (31). However, a greater difficulty than any of these may be discerned.

It seems to me that the limitations of Krutilla's argument lie in his assumptions about how quickly spoiled environments can be restored (rate of reversion) and how great the supply of environments is. Krutilla *et al.* are sensitive to the possibility that the rate of reversion may well be amenable to technological intervention (29, p. 110):

Perhaps more significant, however, is the need to investigate more fully the presumption of asymmetric implications of technological progress for the value of attributes of the natural environment when used as intermediate goods, compared with their retention as assets supplying final consumption services. Irreproducibility, it might be argued, is not synonymous with irreplaceability. If reasonably good substitutes can be found, by reliance on product development, the argument for the presumption of differential effects of technological progress is weakened; or if not weakened, the value which is selected [for the reversion rate] . . . would not remain unaffected.

The supply of natural environments is affected by technology in that it can manipulate both biological processes and information and significance. The advertising that created rare environments can also create plentiful substitutes. The supply of special environments can be increased dramatically by highlighting (in ways not uncommon to those of differentiating among groups of equivalent toothpastes) significant and rare parts of what are commonly thought to be uninteresting environments.

The accessibility of certain environments to population centers can be altered to create new rare environments. Also, environments that are especially rare, or are created to be especially rare, could be very far away, since people would be willing to pay more to see them. Thus it may be possible to satisfy a large variety of customers for rare environments. The following kind of situation might result.

1) Those individuals who demand "truly" natural environments could be encouraged to fly to some isolated location where a national park with such an environment is maintained; a substantial sum of money would be required of those who use such parks.

2) For those who find a rare environment in state parks or perhaps in small national parks, such parks could be made more accessible and could be developed more. In this way, a greater number of people could use them and the fee for using them would be less than the fee for using isolated areas.

3) Finally, for those who wish to have an environment that is just some trees, some woods, and some grass, there might be a very small park. Access would be very easy, and the rareness of such environments might well be enhanced beyond what is commonly thought possible by means of sophisticated methods of landscape gardening (32).

It seems to me that, as Krutilla sug-

gests, the demand for rare environments is a learned one. It also seems likely that conscious public choice can manipulate this learning so that the environments which people learn to use and want reflect environments that are likely to be available at low cost. There is no lack of merit in natural environments, but this merit is not canonical.

### The Valuation of the Future

In any cost-benefit analysis that attempts to include future values, the rate at which the future is discounted is crucial to the analysis. (That is, a sum of money received today is worth more to us now than the same sum received in the future. To allow for this, one discounts, by a certain percent each year, these future payments.) Changes in discount rates can alter the feasibility of a given project. If different clientele's preferences for projects correspond to different discount rates at which these projects are feasible, then the choice of a particular discount rate would place the preferences of one group over another. Preservation yields benefits that come in the future. The rich have a low rate of discount compared to the poor (say, 5 percent as opposed to 10 or 20 percent) and would impute much higher present value to these future benefits than the poor would. Baumol suggests (though it is only a hunch) that (33, pp. 801-802):

. . . by and large, the future can be left to take care of itself. There is no need to lower artificially the social rate of discount in order to increase further the prospective wealth of future generations. . . . However, this does not mean that the future should in every respect be left at the mercy of the free market. . . . Investment in the preservation of such items then seems perfectly proper, but for this purpose the appropriate instrument would appear to be a set of selective subsidies rather than a low general discount rate that encourages indiscriminately all sorts of investment programs whether or not they are relevant.

Baumol is saying that the process of preserving environments may not always be fruitfully analyzed in terms of cost-benefit analyses; we are preserving things in very special cases, and each choice is not a utilitarian choice in any simple sense, but represents a balancing of all other costs to the society of having *no* preserved environments. Preservation often entails a gross change in policy, and utilitarian analyses cannot easily compare choices in which values may be drastically altered.

### Other Criteria

We may decide to preserve things just because they are rare. In that case, we need to know which things are rarer than others. Leopold has tried to do this for a set of natural environments (34). He listed a large number of attributes for each environment and then weighted each attribute as follows. For any single attribute, determine how many environments share that attribute and assign each of them a value of  $1/N$  units, where  $N$  is the number of environments that share an attribute. Then add all the weights for the environments; the environment with the largest weight is the rarest. It is clear that, if an environment has attributes which are unique, it will get one unit of weight for each attribute and thus its total weight will just equal the number of attributes. If all of the environments are about the same, then each of them will have roughly the same weight, which will equal the number of attributes divided by the number of environments. The procedure is sensitive to how differentiated we wish to make our attributes and to the attributes we choose. It is straightforward and usable, as Leopold has shown.

It seems to me that there are two major difficulties in this approach. The first, and more important, is that the accessibility of environments to their clientele, which Leopold treats as one of his 34 attributes, needs to be further emphasized in deciding what to preserve. An environment that is quite rare but essentially inaccessible may not be as worthy of preservation as one that is fairly common but quite accessible (35). The other difficulty is that probably the quantity that should be used is the amount of information possessed by each environment—rather than taking  $1/N$ , one should take a function of its logarithm to the base 2.

An ecological argument is that environments which contribute to our stability and survival as an ecosystem should be preserved. It is quite difficult to define what survival means, however. If it means the continued existence of man in an environment quite similar to the one he lives in now, then survival is likely to become very difficult as we use part of our environment for the maintenance of life and as new technologies come to the fore. If survival means the maintenance of a healthy and rich culture, then ecology can only partially guide us in the choices, since technology has substantially changed

the risk from catastrophe in the natural world (36). Our complex political and social organizations may serve to develop means for survival and stability sufficient to save man from the catastrophic tricks of his own technology.

If a taxonomy of environments were established, a few environments might stand out from all the rest. But what would be the criteria involved in such a taxonomy?

Another possibility is to search for relics of cultural, historical, and social significance to the nation. Such physical artifacts are preserved because the experiences they represent affect the nature of the present society. In this sense, forests are preserved to recall a frontier, and historic homes are preserved to recall the individuals who inhabited them. Of course the problem here is that there is no simple way of ordering the importance of relics and their referents. Perhaps a survey of a large number of people might enable one to assign priorities to these relics.

Finally, it might be suggested that preservation should only be used, or could sometimes be used, to serve the interests of social justice. Rather than preserving things for what they are or for the experiences they provide, we preserve them as monuments to people who deserve commemoration or as a means of redistributing wealth (when an environment is designated as rare, local values are affected). Rather than buy forests and preserve them, perhaps we should preserve slums and suitably reward their inhabitants.

All of these criteria are problematic. Whichever ones are chosen, priorities for intervention must still be developed.

### Priorities for

#### Preserving the Environment

Not every problem in environmental quality is urgent, nor does every undesirable condition that exists need to be improved. We need to classify environmental problems in order that we can choose from among the possible improvements.

1) There are conditions about which we must do something soon or we will lose a special thing (37). These conditions pertain especially to rare environments, environments we wish to preserve for their special beauty or their uniqueness. We might allocate a fixed amount of money every year to such urgent problems. Niagara Falls might be one of these, and it might cost a

fraction of a dollar per family to keep it in good repair. Wilderness and monument maintenance have direct costs of a few dollars per family per year (38).

2) There are situations in which conditions are poor, but fairly stable. In such situations, it might be possible to handle the problem in 10 years without too much loss. However, the losses to society resulting from the delayed improvement of these facilities need to be carefully computed. For example, the eutrophied Lake Erie might be such a project. There, society loses fishing and recreational facilities. It might cost \$100 per family, locally, to clean up the lake. Perhaps our environmental dollar should be spent elsewhere (39).

3) There are also situations in which conditions are rapidly deteriorating and in which a small injection of environmental improvement and amelioration would cause dramatic changes in a trend. Smog control devices have probably raised the cost of driving by 2 or 3 percent, yet their contribution to the relative improvement of the environment in certain areas (for example, Los Angeles) has been substantial. Fifty dollars per car per year is the estimated current cost to the car owner (40).

4) There may be situations in which large infusions of money are needed to stop a change. These problems are especially irksome. Perhaps the best response to them would be to change the system of production sufficiently that we can avoid such costs in the future. The costs of such change, one-time costs we hope, may be much smaller than the long-term costs of the problems themselves, although this need not be the case. The development of cleaner industrial processes is a case in point (41).

This is not an all-inclusive or especially inventive classification of problems, but I have devised it to suggest that many of the "urgent" problems are not so urgent (42).

Rare environments pose special problems and may require an approach different from that required by other environments. A poor nation is unlikely to destroy very much of its special environments. It lacks the technical and economic power to do so. It may certainly perform minor miracles of destruction through a series of small decisions or in single, major projects. These latter are often done with the aid of rich countries.

The industrialized, but not wealthy,

nations have wreaked havoc with their environments in their efforts to gain some degree of wealth. It is interesting that they are willing to caution the poor nations against such a course, even though it may be a very rapid way of developing. At the U.N. Conference on the Environment this year, the poor nations indicated their awareness of these problems and their desire to develop without such havoc.

The rich nations can afford to have environments that are rare and consciously preserved. These environments are comparable to the temples of old, in that these environments will be relics of *our* time, yet this is no criterion for deciding how much should be spent on "temple building." The amount of money needed is only a small proportion of a rich country's wealth (as opposed to the cost of churches in medieval times).

Politically, the situation is complicated. There are many small groups in this country for whom certain environments are highly significant. The problem for each group is to somehow get its piece of turf, preferably uncut, unrenewed, or untouched. It seems likely that the ultimate determinant of which environments are preserved will be a process of political trade-off, in which some environments are preserved for some groups and other environments for others. Natural environments are likely to be viewed in a continuum with a large number of other environments that are especially valued by some subgroup of the society. In this sense, environmental issues will become continuous with a number of other special interests and will no longer be seen as a part of a "whole earth" movement. The power of the intellectuals, in the media, and even in union bureaucracies, with their upper middle class preferences for nature, suggests that special interest groups who are advocates for the poor and working classes will have to be wary of their own staffs.

Projects might be ranked in importance on the basis of the net benefits they provide a particular group. Marglin has suggested a means by which income redistribution could be explicitly included in cost-benefit calculations for environmental programs (43). If one wishes to take efficiency into account, costs minus benefits could be minimized with a constraint relating to income redistribution. This is not a simple task, however, because pricing some commodities at zero dollars, seemingly



the best way of attempting a redistribution of income, may not be politically desirable or feasible. As Clawson and Knetch have pointed out, we have to be sure that in making some prices low we do not make others prohibitively high and thereby deny the persons who are to benefit access to the low-priced goods (44). In any case, Marglin shows that the degree to which income is redistributed will depend on how the same amount of money might have been spent in alternative activities (marginal opportunity cost). This parallels Kneese and Bower's view that the level of pollution we tolerate, or is "optimal," is that at which the marginal benefits of increasing pollution are balanced by the marginal costs of abatement measures (45).

In doing these cost-benefit calculations, one must consider the value of 10 years of clean lake (if we can clean up the lake now) versus 10 years of uneducated man (if we wait 10 years for a manpower training program). According to Freeman (46):

... [the] equity characteristics of projects within broad classifications . . . will be roughly similar. If this surmise is correct, then the ranking of projects within these classes is not likely to be significantly affected by equity considerations. On the other hand, we would expect more marked differences in distribution patterns among classes of projects, e.g., rural recreation vs. urban air quality.

He goes on to point out that it is unlikely that such seemingly incommensurable kinds of projects will be compared with respect to equity. I suspect that it is still possible to affect specific groups in the design of a given project; furthermore, equity can be taken into consideration more concretely at this level. Careful disaggregation, in measuring effects and benefits, will be needed to ensure that minorities are properly represented.

### An Ethical Question

I still feel quite uncomfortable with what I have said here. I have tried to show that the utilitarian and manipulative rationality inherited from the conservationist movement and currently embodied in economic analyses and modes of argument can be helpful in deciding questions of preservation and rarity. By manipulating attitudes, we have levers for intervening into what is ordinarily considered fixed and uncontrollable. But to what end?

Our ability to manipulate preferences and values tends to lead to systems that make no sense. For example, an electrical utility encourages its customers to use more electricity, and the customers proceed to do so. As a result, there are power shortages (47). Similarly, if we allocate resources now in order to preserve environments for future generations, their preferences for environments may be altered by this action, and there may be larger shortages.

I also fear that my own proposals might get out of hand. My purpose in proposing interventions is not to preserve man's opportunity to experience nature, although this is important, but to promote social justice. I believe that this concern should guide our attempts to manipulate, trade off, and control environments. A summum bonum of preserving trees has no place in an ethic of social justice. If I took this ethic seriously, I could not argue the relative merits of schemes to manipulate environments. I would argue that the ecology movement is wrong and would not answer its question about what we are going to do about the earth—I would be worried about what we are going to do about men.

### Conclusion

With some ingenuity, a transformation of our attitudes toward preservation of the environment will take place fairly soon. We will recognize the symbolic and social meanings of environments; not just their economic utility; we will emphasize their historical significance as well as the future generations that will use them.

At the same time, we must realize that there are things we may not want to trade at all, except in the sense of letting someone else have his share of the environment also. As environments become more differentiated, smaller areas will probably be given greater significance, and it may be possible for more groups to have a share.

It is likely that we shall want to apply our technology to the creation of artificial environments. It may be possible to create environments that are evocative of other environments in other times and places. It is possible that, by manipulating memory through the rewriting of history, environments will come to have new meaning. Finally, we may want to create proxy

environments by means of substitution and simulation. In order to create substitutes, we must endow new objects with significance by means of advertising and by social practice. Sophistication about differentiation will become very important for appreciating the substitute environments. We may simulate the environment by means of photographs, recordings, models, and perhaps even manipulations in the brain (48). What we experience in natural environments may actually be more controllable than we imagine (49). Artificial prairies and wildernesses have been created, and there is no reason to believe that these artificial environments need be unsatisfactory for those who experience them.

Rare environments are relative, can be created, are dependent on our knowledge, and are a function of policy, not only tradition. It seems likely that economic arguments will not be sufficient to preserve environments or to suggest how we can create new ones. Rather, conscious choice about what matters, and then a financial and social investment in an effort to create significant experiences and environments, will become a policy alternative available to us.

What's wrong with plastic trees? My guess is that there is very little wrong with them. Much more can be done with plastic trees and the like (50) to give most people the feeling that they are experiencing nature. We will have to realize that the way in which we experience nature is conditioned by our society—which more and more is seen to be receptive to responsible interventions.

Bentham, the father of utilitarianism, was very concerned about the uses of the dead to the living and suggested (51):

If a country gentleman have rows of trees leading to his dwelling, the autoicons [embalmed bodies in an upright position] of his family might alternate with the trees; copal varnish would protect the face from the effects of rain—caoutchouc [rubber] the habiliments.

### References and Notes

1. There is little reason to doubt that Reagan said this or something close to it to the Western Wood Products Association in early March 1966. Citations are difficult to find. See, however, F. Kiefer, Ed., *i goofed, The Wise and Curious Sayings of Ronald Reagan, 33rd Governor of California* (Diablo Press, Berkeley, 1968), pp. 45-46, which has a reference for this statement from the Sacramento Bee, 12 March 1966. A different version is given in C. Gentry, *The Last Days of the Late, Great State of California* (Putnam, New York, 1968), p. 39. Yet a different version is suggested in the *New York Times*, 21 September 1966, p. 29.



2. Barnett and Morse (3) point out that most natural resources have not risen in price, or that scarcity effects have not become very significant, because of technological (knowledge resources) and substitution (organizational resources) effects. The only seeming exception, forests, have in recent times been quite responsive to technological and substitution effects.
3. H. Barnett and C. Morse, *Scarcity and Growth* (Johns Hopkins Press, Baltimore, 1963).
4. This article is a continuation of M. H. Krieger (3).
5. M. H. Krieger, *Policy Sci.* 1, 311 (1970).
6. R. Meier, *J. Amer. Inst. Plann.* 37, 211 (1971).
7. It may be true that the movement should not offer alternatives. Perhaps "eco-activists should relentlessly pursue their goals, and pursue them with 'confrontation tactics' if necessary" [R. Dunlap and R. Gale, "Politics and ecology: a political profile of student eco-activists," mimeographed, Department of Sociology, University of Oregon (April 1970), p. 20; see —, *Youth Soc.* 3, 379 (1972), where this section has been deleted]. See also —, "Student recruitment into the environmental movement: a test of a reformulation of 'Mass Society' theory," mimeographed, University of Oregon (August 1971) and R. Faich and R. Gale, *Pac. Sociol. Rev.* 14, 270 (1971). If this comes about, a mediating movement will arise, composed of individuals who will call themselves "rational" and who will have to negotiate between the ecology movement and its opponents. The mediating individuals will find the policy discussed in this article relevant to their concerns. See D. Morrison, K. Hornback, W. Warner, in *Social Behavior, Natural Resources and the Environment*, W. Burch, N. Cheek, L. Taylor, Eds. (Harper & Row, New York, 1972).
8. They have, however, been manipulated enough to have rid Europe of forests and to have created deserts in Africa.
9. Perhaps the products of the U.N. Conference on the Environment (5-16 June 1972) will do better. A proposal, unacted on, as far as I know, "to establish a World Heritage Foundation of those areas distinctive enough to be of interest to all mankind—for example, the Grand Canyon or the game preserves in Kenya" manifests some of the preconference international interest (presumably stimulated by rich countries) [R. Bazell, *Science* 174, 390 (1971)]. The manner in which the environmental question is being raised on the international level, especially the manner in which the rich countries view the poorer ones, is strikingly similar to how the rich behave toward the poor in the United States (5, pp. 323-324).
10. See H. Huth, *Nature and the American* (Univ. of California Press, Berkeley, 1957), plate 1, for a photo of Niagara Falls. See also, pp. 171-173 and 206-207 for some history of preservation efforts.
11. See the *New York Times*, 22 March 1969, p. 1; 4 May 1969, p. 9; 3 August 1969, p. 64; 26 November 1969, p. 47; 12 July 1970, p. 56; 28 March 1971, p. 103, for more recent details. The *Buffalo Evening News* provides more details: 9 November 1970, 13 November 1970, 4 February 1971, 10 March 1971, and 23 March 1971.
12. The committee's final set of alternatives is not the same as those given here, but it is similar. Most of these details come from the American Falls International Board (13). Another example: "The Old Man of the Mountains at Franconia, N.H., was in danger of losing part of its nose by erosion and engineers for the New Hampshire Department of Public Works went to the rescue. It was the second face-lifting in 14 years for the natural (!) formation . . ." [Kansas City *Star*, 26 August 1972, p. 1].
13. American Falls International Board, "Preservation and enhancement of the American Falls at Niagara," mimeographed, Interim report to the International Joint Commission, Buffalo, N.Y. (December 1971).
14. R. Nash, *Wilderness and the American Mind* (Yale Univ. Press, New Haven, Conn., 1967).
15. W. R. Burch, Jr., *Daydreams and Nightmares: A Sociological Essay on the American Environment* (Harper & Row, New York, 1971); T. Maldonado, *Design, Nature, and Revolution* (Harper & Row, New York, 1972), pp. 1-20, 73-77.
16. D. Houston, *Science* 172, 648 (1971). Note that "preserving" dynamic natural ecosystems implies their being altered, except in the case of climax communities.
17. W. Firey, *Man, Mind, and Land* (Free Press, Glencoe, Ill., 1960). It may be that in the future the returns from additional knowledge will decline. See R. Meier, "Resource-conserving cities: the metropolis as a resource consumer," mimeographed, University of California, Berkeley (1969), p. 6. At this time, however, it seems unlikely that the value of knowledge in understanding our environments is very much realized; therefore, substantial returns on an investment in knowledge should be expected for the next few decades.
18. A. Hamilton, *The Manchester Guardian*, 4 September 1971, p. 8.
19. G. Glueck, *New York Times Book Review*, 7 November 1971, p. 36.
20. This analysis is as useful for paintings in museums and stamps in collections as it is for trees in parks. Art museums are places where rare objects are preserved in order to enhance the quality of experience available to people. [Graña's discussions of museums makes the analogy with rare natural environments stand out. The conflict between the didactic ("New York" style) and the pure ("Boston" style) approaches to museum organization reminds one of the conflict between recreationists and preservationists. These conflicts reflect, of course, much larger issues in mass society. See C. Graña, *Transaction* 4, 20 (April 1967)]. Originally, they were developed to help artists by showing their works, thereby institutionalizing the artist's relationships with his patron-clients. Eventually, these galleries became sources of orthodoxy, thereby establishing what the acceptable forms of art were. [F. Haskell, in *International Encyclopedia of the Social Sciences*, D. Sills, Ed. (Macmillan, New York, 1968), vol. 5, p. 439.] The creation of museums and their continued development is not simply a product of the increased rareness of works of art, per se, for the rareness of a work of art is actually, in part, the result of museums. The stock of art must be viewed in terms of public and private consumption. If it is believed that the public ought to have access to art, then putting art in private collections uses it up, as far as the public is concerned. An ideology that encourages the development of means of public consumption of art—for example, building museums in order to be saved either after a life of sin (as in the case of the robber barons) or from taxes—rescues these objects from oblivion.
21. C. Renfrew, *Sci. Amer.* 225, 63 (October 1971).
22. G. Kubler, *The Shape of Time* (Yale Univ. Press, New Haven, Conn., 1962).
23. J. Harrell, *J. Aesthet. Art Crit.* 25, 171 (1966).
24. A. Lessing, *ibid.* 23, 461 (1965). The degree of concern about forgery and authenticity seems to be characteristic of a given time and a given culture. Reviews of a new book about Coleridge [N. Fruman, *Coleridge, The Damaged Archangel* (Braziller, New York, 1971)] make this point. For example, ". . . Romanticism itself 'depended in part on a certain gullibility in readers, a willingness to be duped'; that the cult of ruins, including modern faked ones, paralleled the cult of the fraudulently horrific Gothic novel, and paralleled, too, the Romantic willingness to accept Coleridge's word. . . 'Romantics and forgers,' the reviewer continues, 'are necessarily on amicable terms, because both demand that we submit to an illusion, that we concur in waking and finding a dream to be truth'" [C. Ricks, *Sat. Rev.* 40, 31 (15 January 1972.) This is very suggestive, considering the origin of modern concepts of wilderness.
25. J. Krutilla, *Amer. Econ. Rev.* 57, 777 (1967).
26. B. Weisbrod, *Quart. J. Econ.* 78, 471 (1964).
27. C. J. Cicchetti, A. Freeman III, J. Krutilla, "Indivisible, non-reproducible, non-storable, unique services, consumed under uncertainty: a technical note on the nature of option value," mimeographed, Resources for the Future, Washington, D.C. (February 1970).
28. A. Fisher, "The optimum uses of natural areas," Xeroxed, Brown University, Providence, R.I.
29. J. V. Krutilla, C. J. Cicchetti, A. M. Freeman III, C. S. Russell, in *Environmental Quality Analysis*, A. V. Kneese and B. T. Bower, Eds. (Johns Hopkins Press, Baltimore, 1972), pp. 69-112.
30. W. Robinson, *Land Econ.* 45, 453 (1969).
31. J. Harry, R. Gale, J. Hendee, *J. Leisure Res.* 1, 246 (Summer 1969); W. B. Devall, *ibid.* 2, 123 (Spring 1970).
32. I do not find this proposal entirely satisfying. Because of its segregating characteristics, it should not be supported by public funds. City parks were originally set up, in part, in order that various classes could mingle. See H. Huth (10, p. 68). Those who advocate preserving the national parks distinguish between recreation and a relation with nature. They have a point, in that most people are city dwellers and would prefer convenient versions of natural experiences. "Heading them off" by providing well-located parks would leave most of the natural parks to the preservationists. See G. Hill, *Sat. Rev.* 40, 40 (1 January 1972).
33. W. Baumol, *Amer. Econ. Rev.* 58, 788 (1968); M. P. Golding, *Monist* 56, 85 (1972). See also J. Rawles, *A Theory of Justice* (Harvard Univ. Press, Cambridge, Mass., 1971), pp. 284-303.
34. L. Leopold, *Nat. Hist.* 78 (No. 4), p. 36 (October 1969); — and M. O. Marchand, *Water Resour. Res.* 4, 709 (1968).
35. F. L. Olmsted, Jr., suggested that, in California, parks be placed at the location of unique resources; most of these resources (given the values of the decision-maker) are in the north. However, a substantial fraction of the population lives in Southern California.
36. C. Starr, *Science* 165, 1232 (1969).
37. This is not unlike Ciriacy-Wantrup's concept of a safe minimum standard of conservation [S. Ciriacy-Wantrup, *Land Econ.* 47, 36 (February 1971); *Resource Conservation* (Univ. of California Press, Berkeley, 1963)].
38. These are intended to be gross estimates of cost. I assume there are 50 million families in the United States. *American Falls* (13) gives estimates of repair costs of \$10 to \$30 million. The government spends something like \$200 to \$500 million each year for national parks, outdoor recreation, and part of the U.S. Forest Service's expenses.
39. This is virtually impossible to estimate without much further elaboration. Stopping the dumping of phosphates (which is only one problem, even if it is the major one) will cost perhaps \$100 million. But cleaning up is a much larger cost, if it is done thoroughly; I estimate that the cost would be \$500 to \$1000 million. I assume that there are 10 to 20 million families in the area.
40. Again it is difficult to estimate costs. Should the costs billed to the driver be used, or perhaps the somewhat smaller costs to the manufacturer? That is, do the costs billed to the consumer reflect the true costs of the pollution-controlling additions? A commonly mentioned amount is \$100 extra in the cost of the car; thus the \$50 estimate, which includes the cost of fuel, is not unreasonable. See L. M. Cook, Ed., *Cleaning Our Environment, The Chemical Basis for Action* (American Chemical Society, Washington, D.C., 1969), p. 56; R. Shinnar, *Science* 175, 1357 (1972).
41. I have put no number here. Obviously many billions of dollars are involved. See, for example, *Bus. Week* (5 February 1972), p. 70.
42. It should be possible to classify each set of problems according to the discount rate at which they become feasible, in a cost-benefit sense.
43. S. A. Marglin, in *Design of Water-Resource Systems*, A. Maass, M. M. Hufschmidt, R. Dorfman, H. A. Thomas, Jr., S. A. Marglin, G. M. Fair, Eds. (Harvard Univ. Press, Cambridge, Mass., 1962), pp. 159-225; *Public Investment Criteria* (M.I.T. Press, Cambridge, Mass., 1967).
44. M. Clawson and J. Knetsch, *Economics of Outdoor Recreation* (Johns Hopkins Press, Baltimore, 1966).
45. A. Kneese and B. Bower, *Managing Water Quality: Economics, Technology and Institutions* (Johns Hopkins Press, Baltimore, 1968).
46. A. Freeman III, in *Environmental Quality Analysis* (Johns Hopkins Press, Baltimore, 1972), pp. 243-278. See also Krieger (5).
47. I realize that the argument is not this simple. Bad planning and difficulties with nuclear power plant start-ups are significant contributors to the current problems. But these difficulties are only small parts of the power production system.
48. R. Schickel, *The Disney Verston* (Simon & Schuster, New York, 1968).
49. The growing field of environmental psychology promises to develop useful knowledge on the nature of these experiences. For a recent

review see K. Craik, in *New Directions in Psychology Four*, K. Craik, B. Kleinmuntz, R. Rosnau, R. Rosenthal, J. A. Cheyne, R. Walters, Eds. (Holt, Rinehart & Winston, New York, 1970), pp. 1-122. On making wildernesses that suit man, see S. H. Spurr, in *Tomorrow's Wilderness*, F. Leydet, Ed., 8th Wilderness Conference (Sierra Club, San Francisco, 1963); and G. Macinko, in *Wilderness, the Edge of Knowledge*, M. E. McCloskey, Ed., 11th Wilderness Conference, (Sierra Club, San Francisco, 1969).

50. The introduction of artificial turf and trees has not been very smooth. Adaptation to the

artificial product and realization of the alternatives takes some time. In the case of turf, some controversy has arisen about its being safe for football players. The rejoinders of manufacturers suggest that players and coaches have to adapt playing styles and equipment to the new surface (see assorted pamphlets from Monsanto, the manufacturer of Astro-turf). Similarly, the introduction of plastic trees in the center meridian of Jefferson Boulevard in Los Angeles has been greeted with much criticism. As set up, there is insufficient support for living plants on the boulevard, and the only alternative is concrete.

51. J. Bentham, *Auto-Icon, or the Uses of the Dead to the Living*, in *Dictionary of National Biography*, L. Stephen and S. Lee, Eds. (Oxford Univ. Press, London, 1917), vol. 2, p. 268.

52. My many conversations with Richard Meier were invaluable. Garrett Eckbo led me to the question of Niagara Falls. Others with whom I have spoken include Dora Crouch, Charlie Cooper, Beverly Driver, Richard Wilkinson, and Blair Bower. This research was supported, in part, by a grant from the Beatrix Farrand Fund of the Department of Landscape Architecture, University of California, Berkeley.